AD-A061 089 AIR FORCE GEOPHYSICS LAB HANSCOM AFB MASS F/G 20/14

REPORT ON PERU SCINTILLATION TESTS - OCTOBER 1976 AND MARCH 197--ETC(U)

DEC 77 H E WHITNEY, J BUCHAU, A L JOHNSON

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2 OF 2

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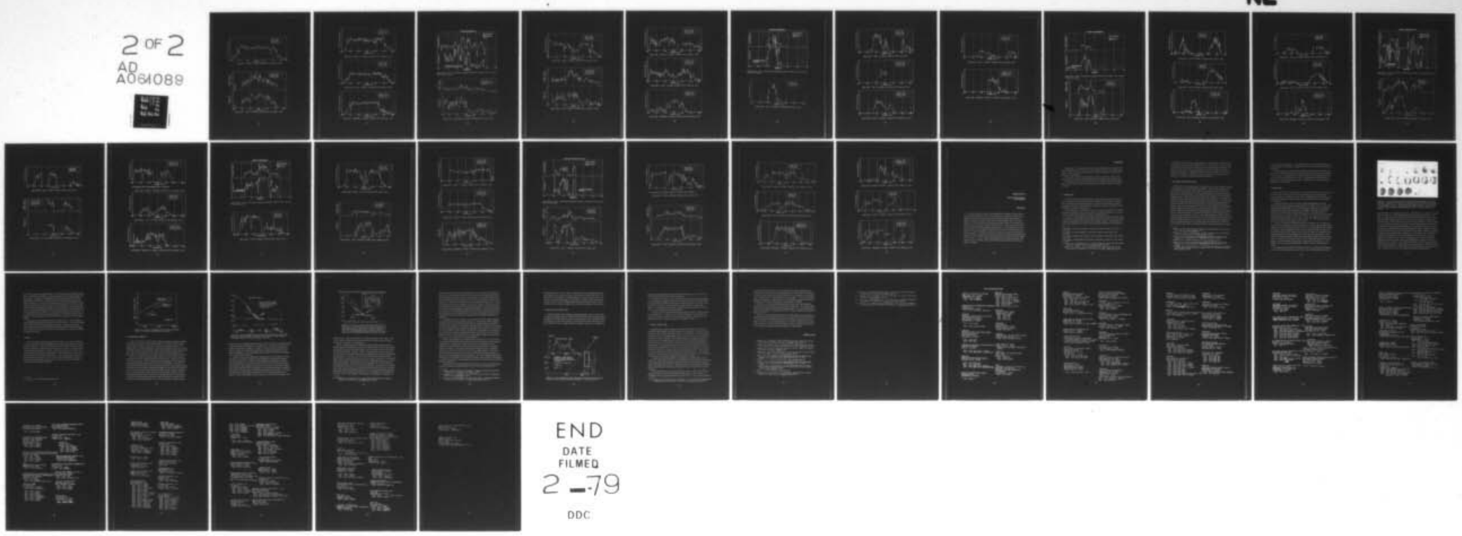

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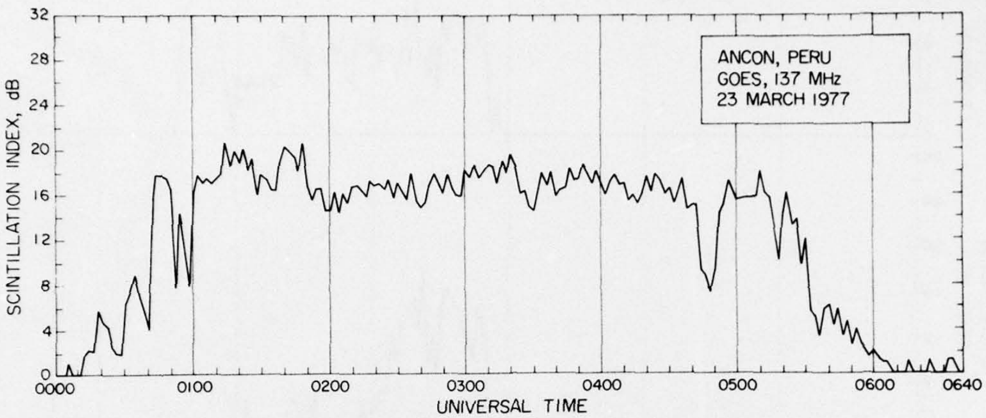


Figure B72. GOES, 137 MHz, 23 March 1977, Ancon, Peru

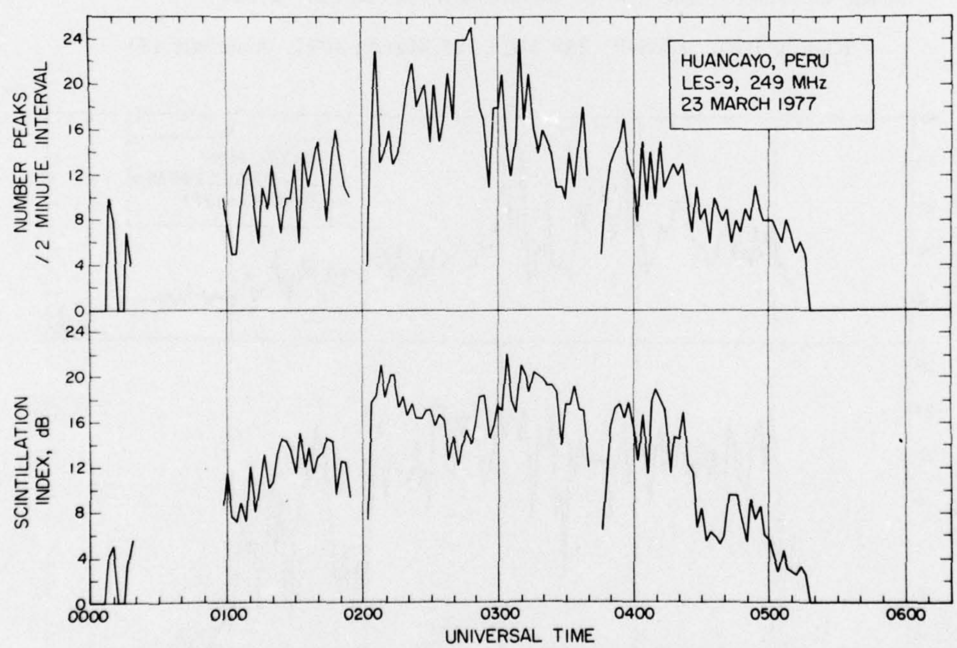


Figure B73. LES-9, 249 MHz, 23 March 1977, Huancayo, Peru

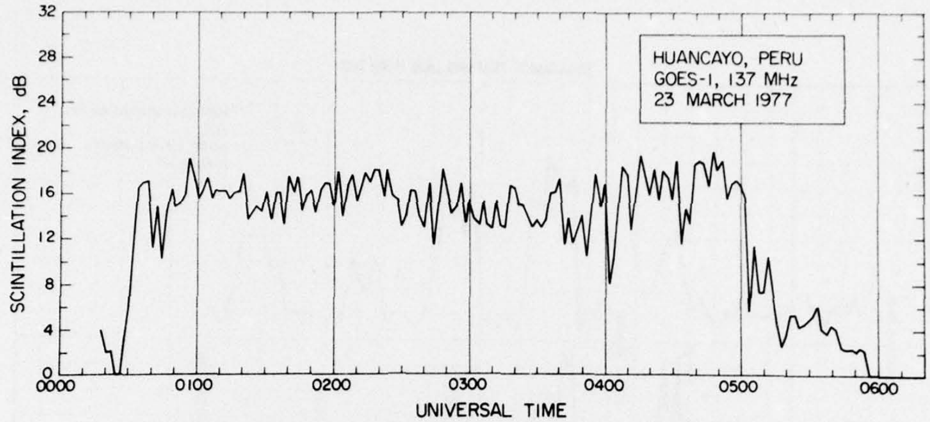


Figure B74. GOES-1, 137 MHz, 23 March 1977, Huancayo, Peru

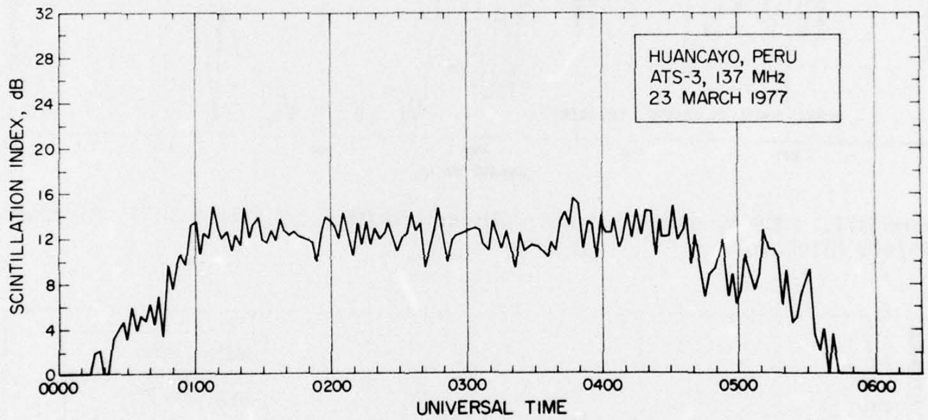


Figure B75. ATS-3, 137 MHz, 23 March 1977, Huancayo, Peru

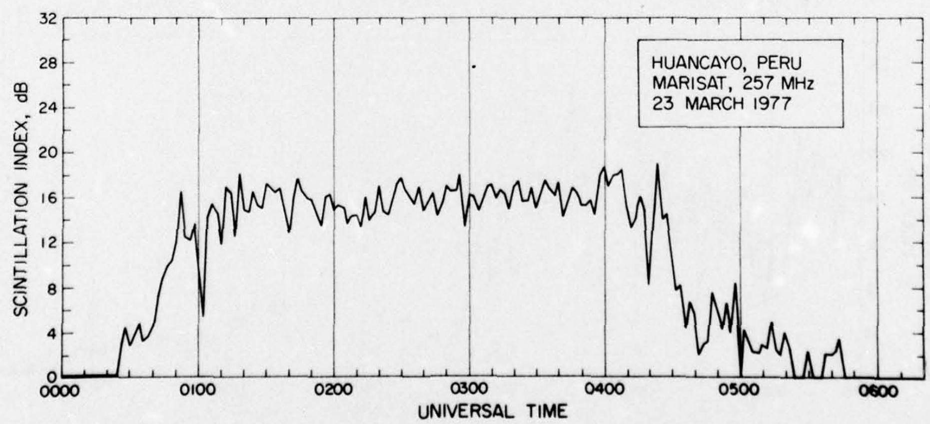


Figure B76. MARISAT, 257 MHz, 23 March 1977, Huancayo, Peru

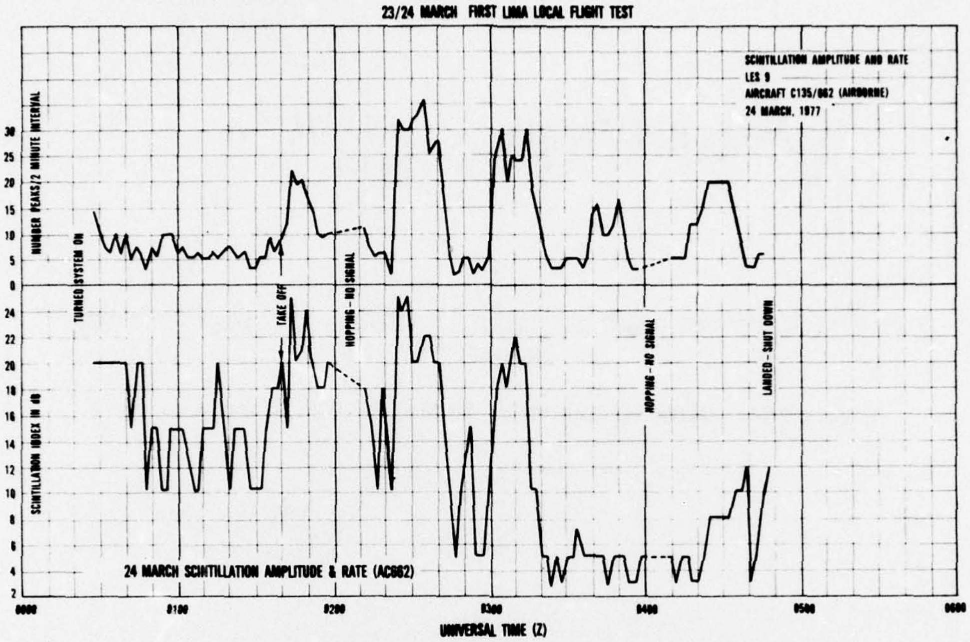


Figure B77. LES-9, Scintillation Amplitude and Rate, 24 March 1977, Aircraft C135/662 (Airborne)

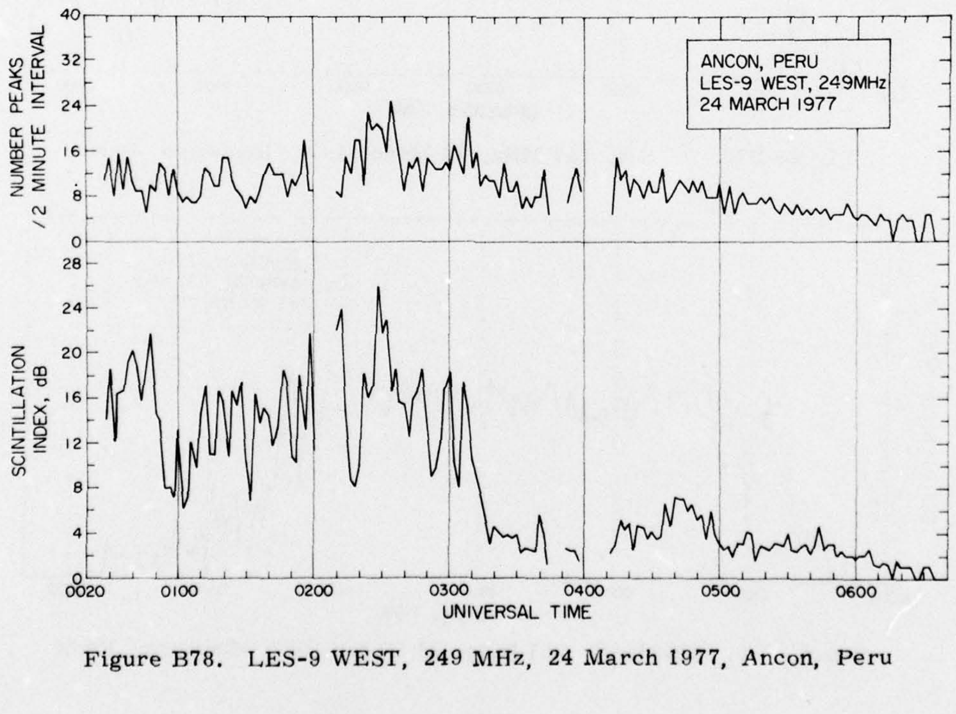


Figure B78. LES-9 WEST, 249 MHz, 24 March 1977, Ancon, Peru

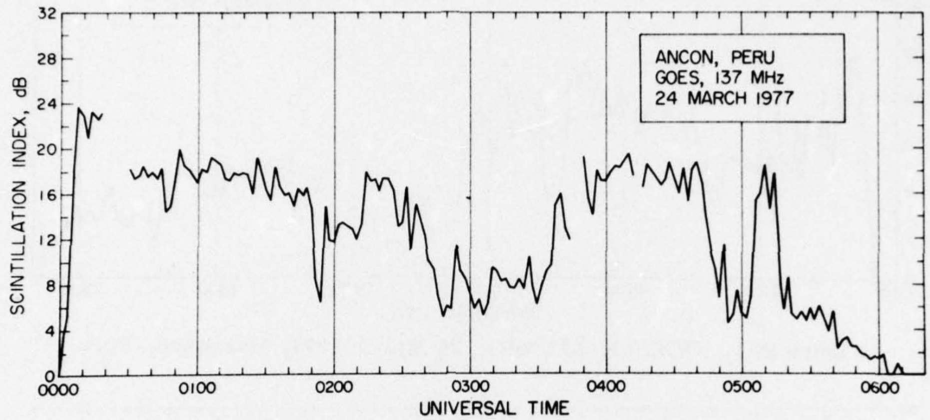


Figure B79. GOES, 137 MHz, 24 March 1977, Ancon, Peru

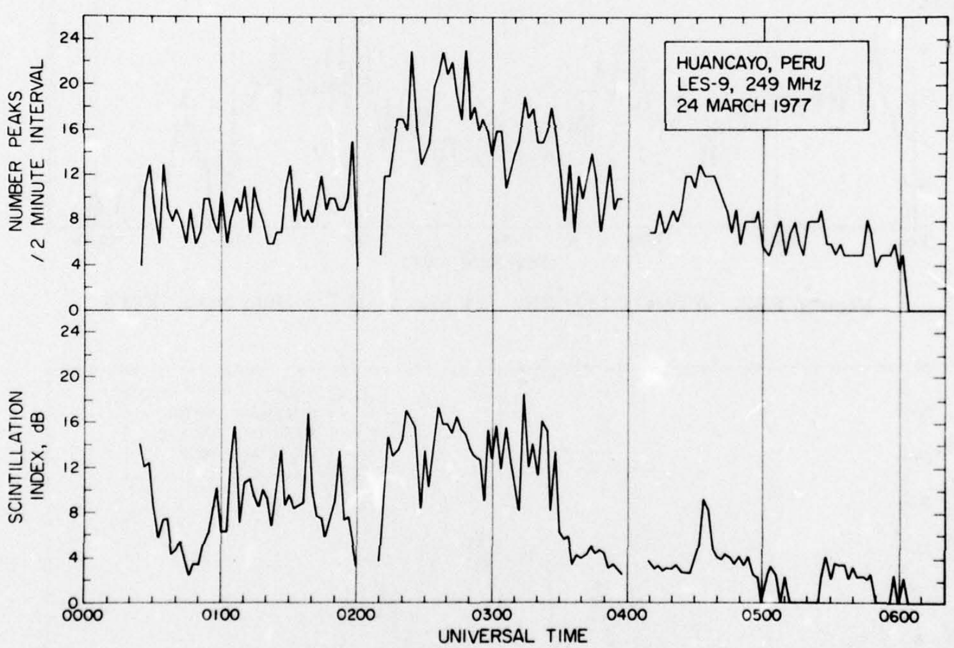


Figure B80. LES-9, 249 MHz, 24 March 1977, Huancayo, Peru

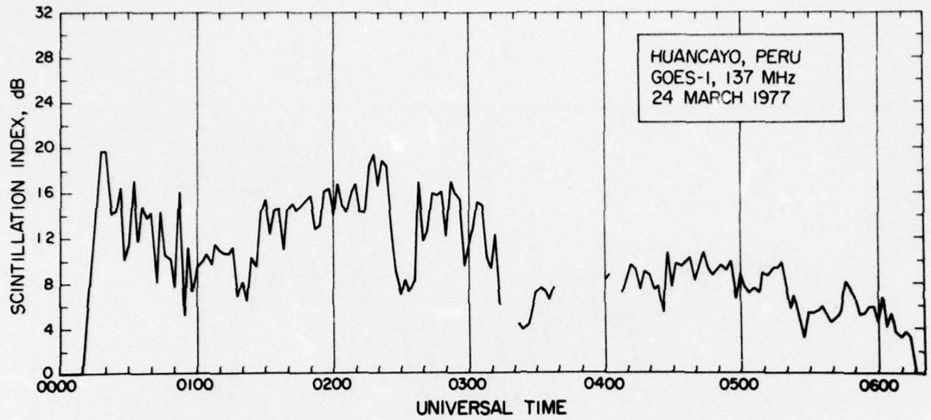


Figure B81. GOES-1, 137 MHz, 24 March 1977, Huancayo, Peru

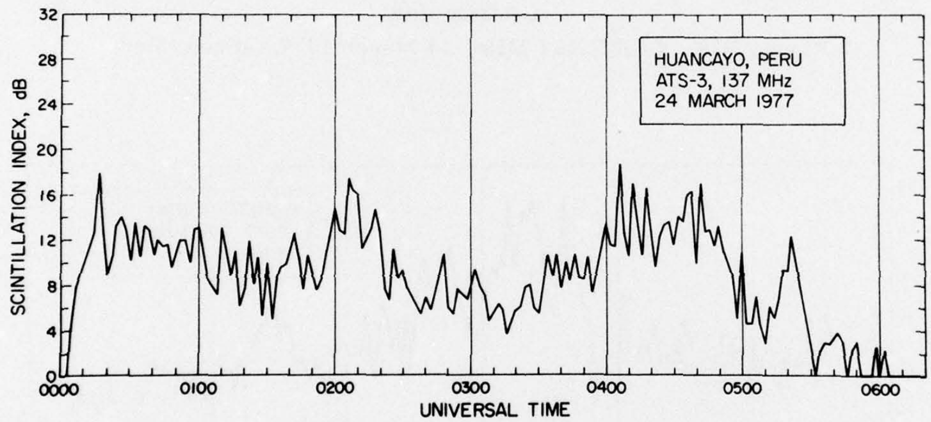


Figure B82. ATS-3, 137 MHz, 24 March 1977, Huancayo, Peru

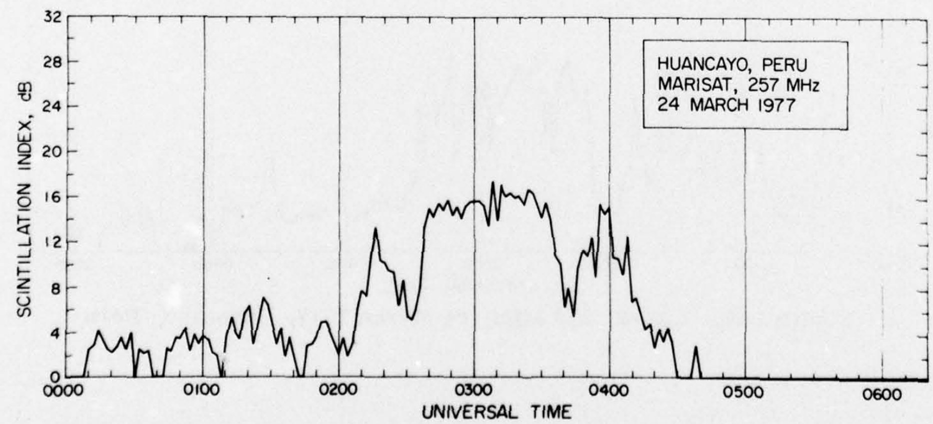


Figure B83. MARISAT, 257 MHz, 24 March 1977, Huancayo, Peru

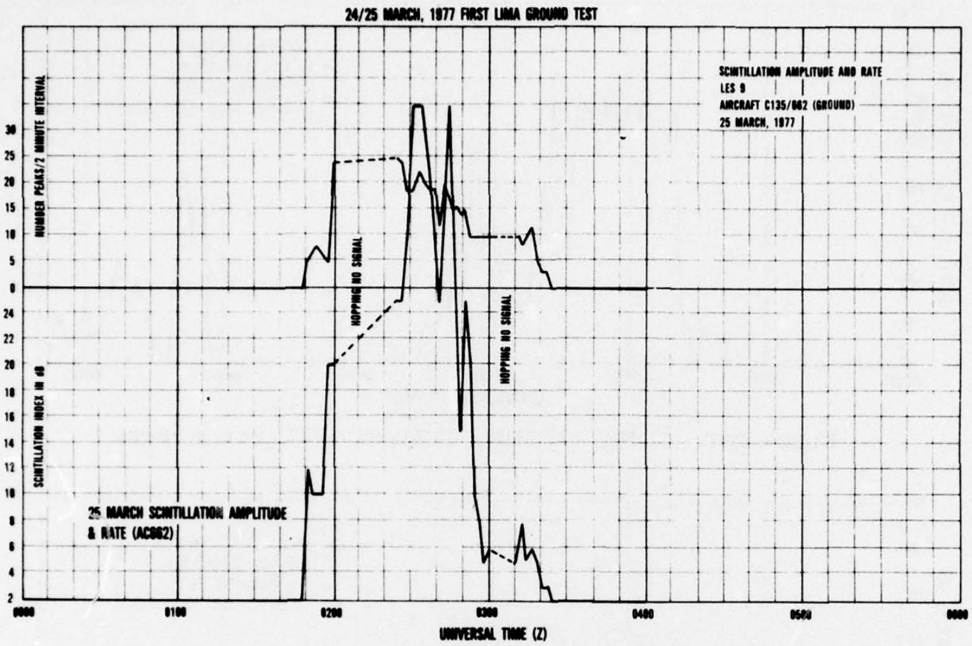


Figure B84. LES-9, Scintillation Amplitude and Rate, 25 March 1977, Aircraft C135/662 (Ground)

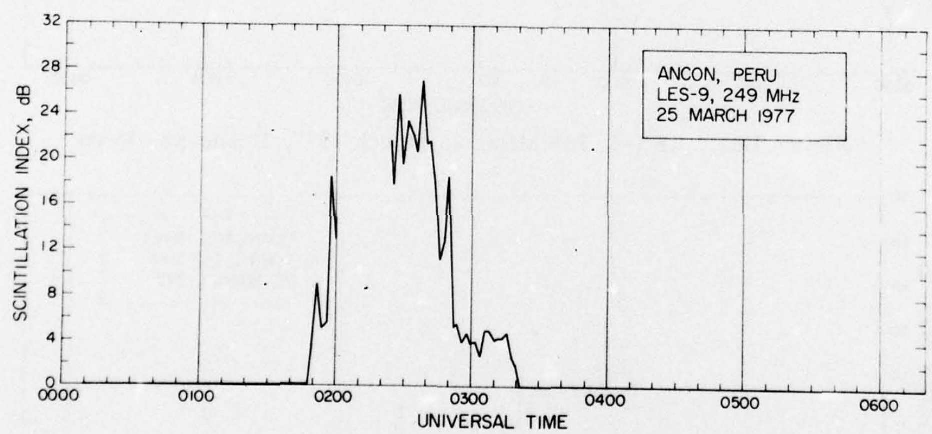


Figure B85. LES-9, 249 MHz, 25 March 1977, Ancon, Peru

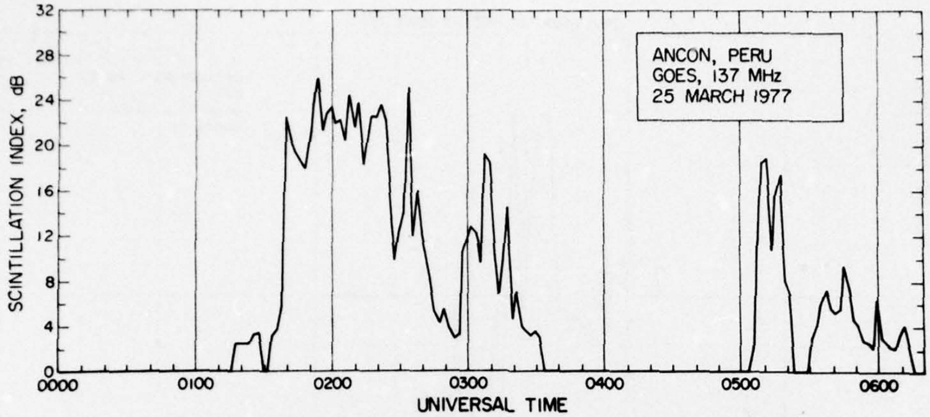


Figure B86. GOES, 137 MHz, 25 March 1977, Ancon, Peru

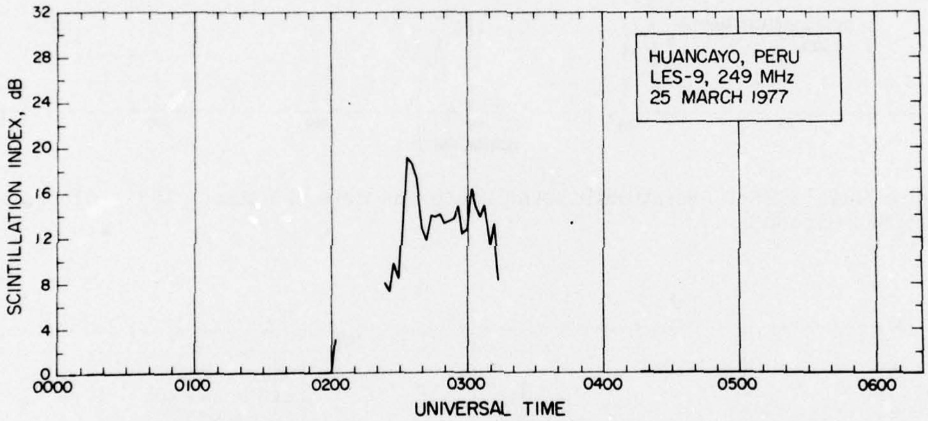


Figure B87. LES-9, 249 MHz, 25 March 1977, Huancayo, Peru

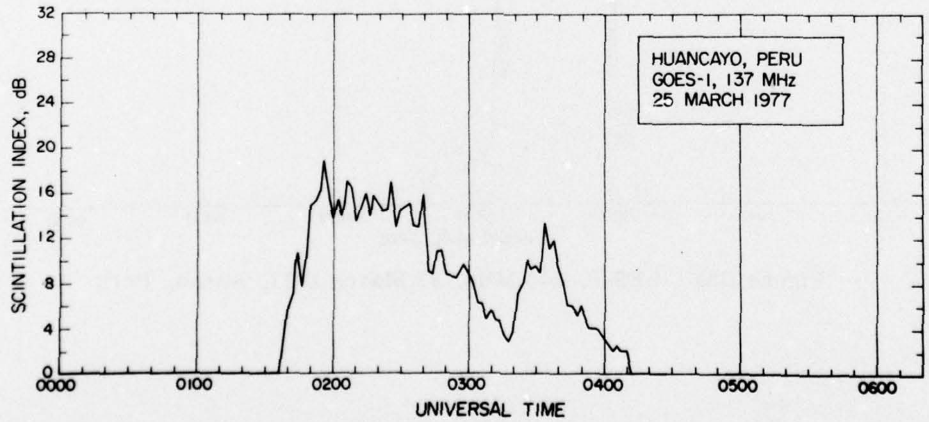


Figure B88. GOES-1, 137 MHz, 25 March 1977, Huancayo, Pero

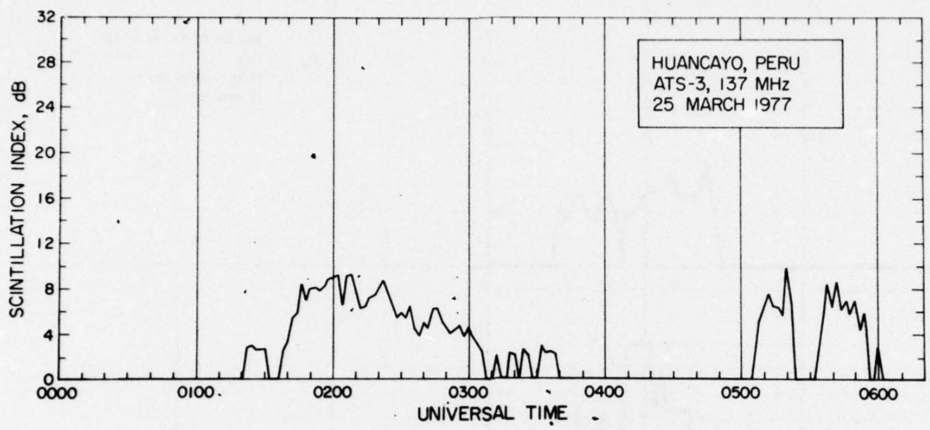


Figure B89. ATS-3, 137 MHz, 25 March 1977, Huancayo, Peru

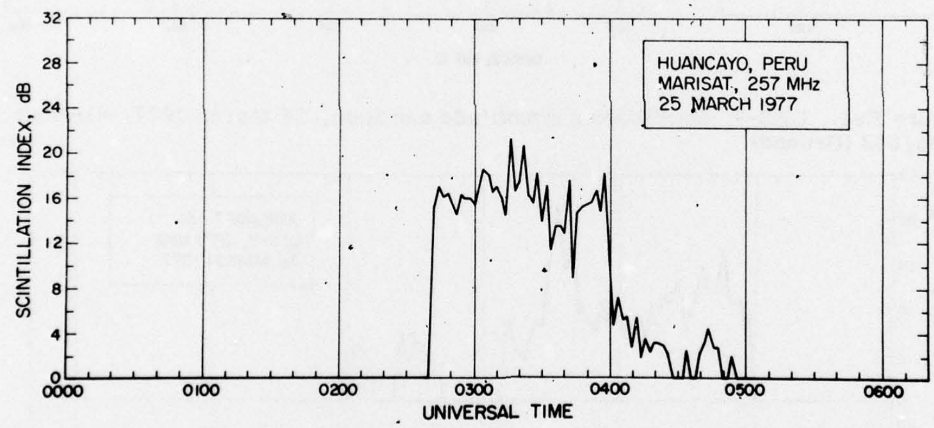


Figure B90. MARISAT, 257 MHz, 25 March 1977, Huancayo, Peru

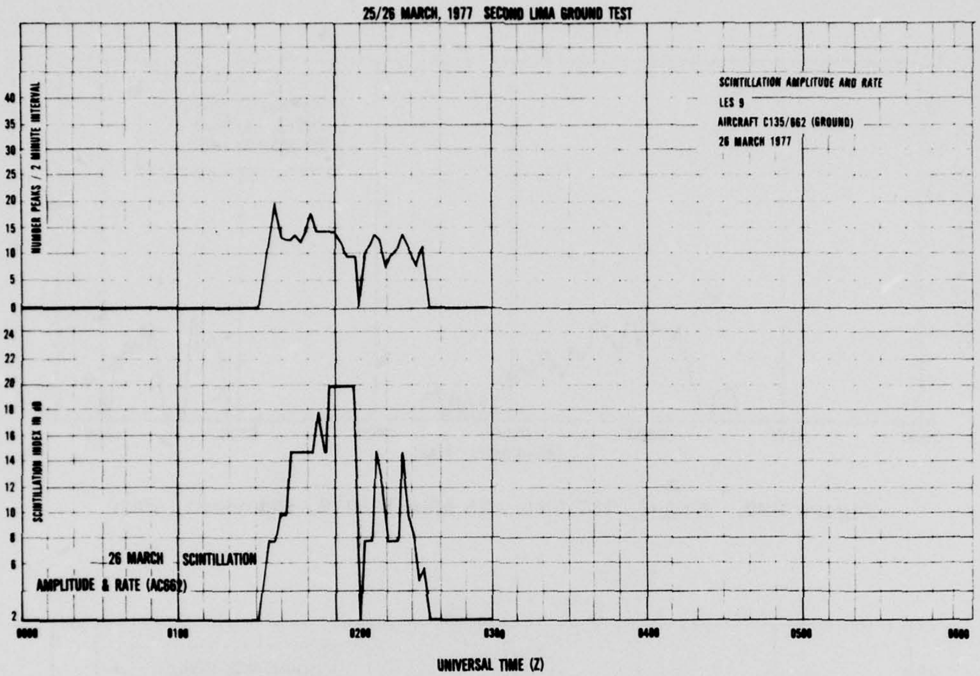


Figure B91. LES-9, Scintillation Amplitude and Rate, 26 March 1977, Aircraft C135/662 (Ground)

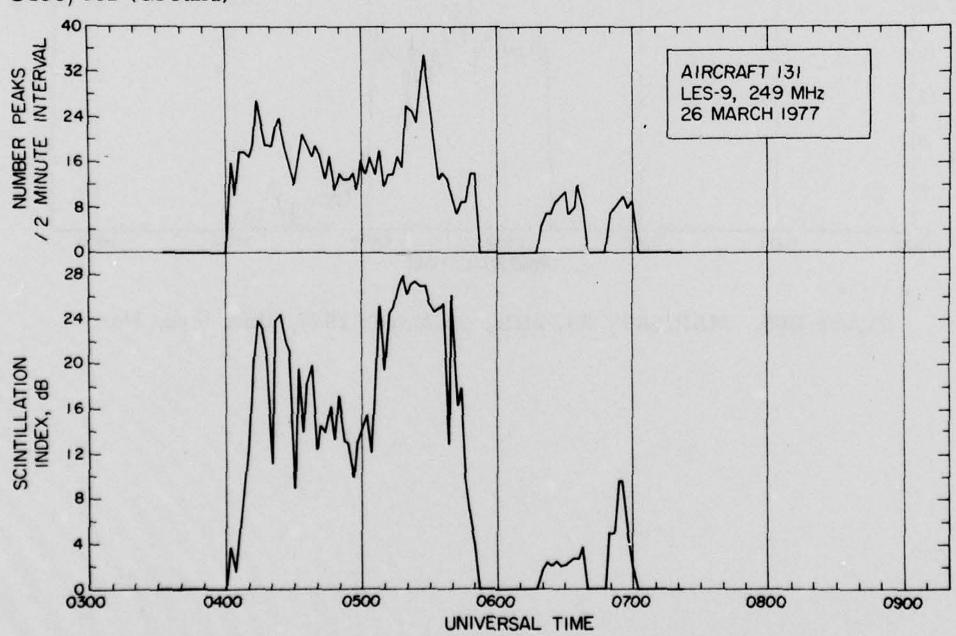


Figure B92. LES-9, 249 MHz, 26 March 1977, Aircraft 131

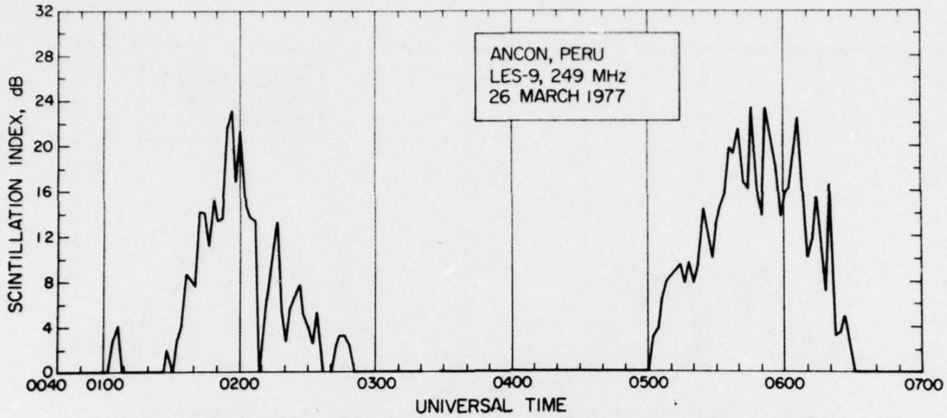


Figure B93. LES-9, 249 MHz, 26 March 1977, Ancon, Peru

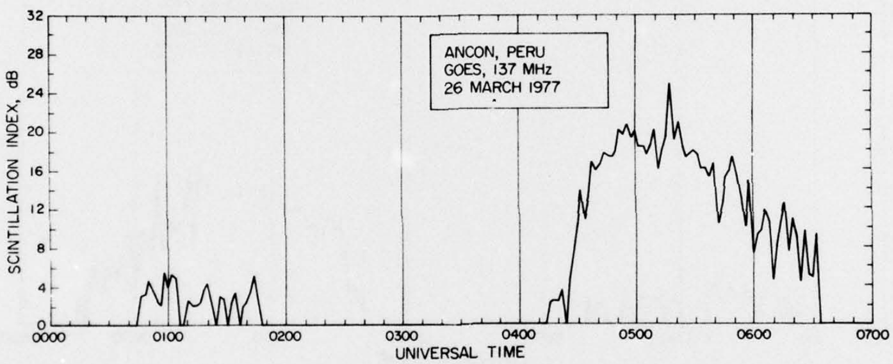


Figure B94. GOES, 137 MHz, 26 March 1977, Ancon, Peru

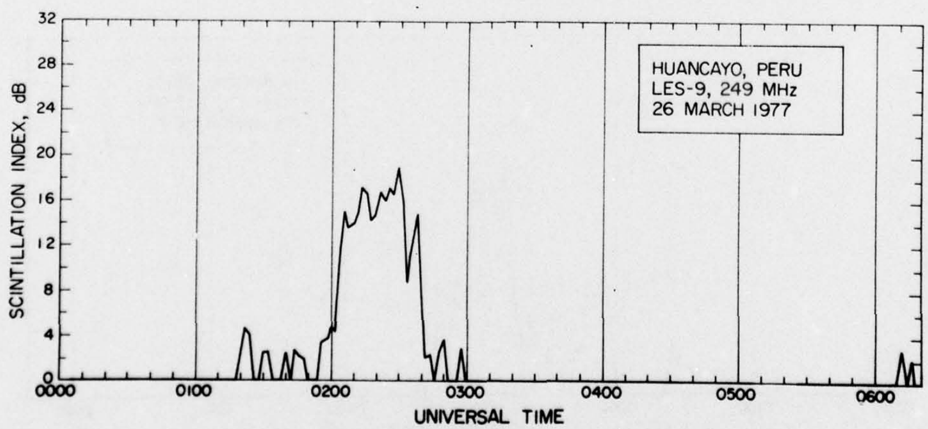


Figure B95. LES-9, 249 MHz, 26 March 1977, Huancayo, Peru

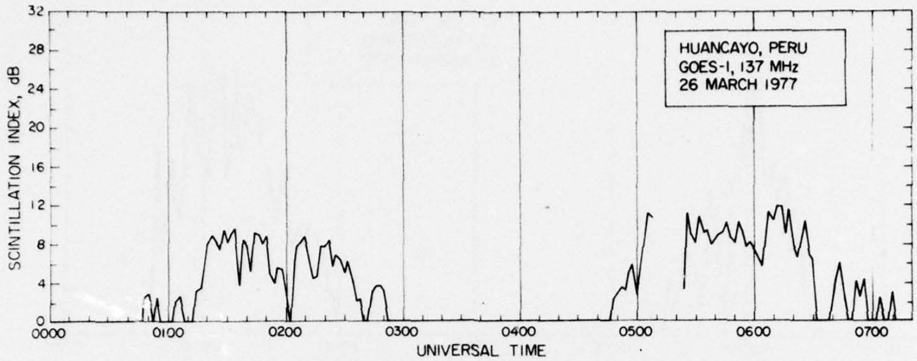


Figure B96. GOES-1, 137 MHz, 26 March 1977, Huancayo, Peru

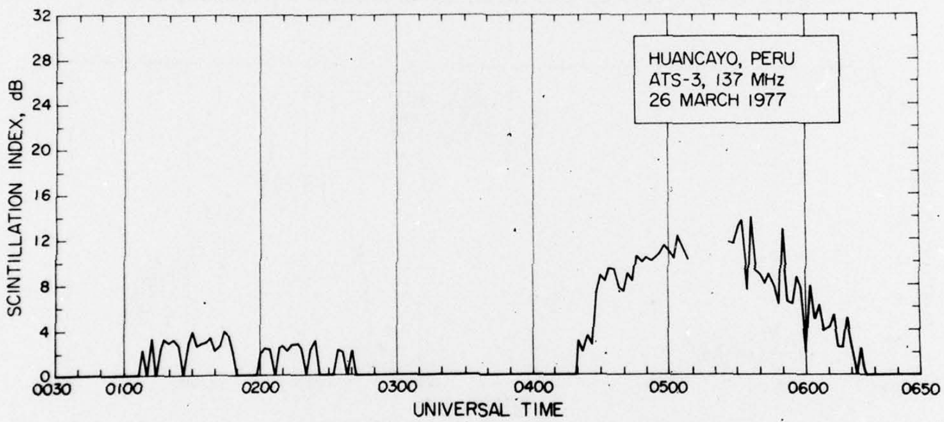


Figure B97. ATS-3, 137 MHz, 26 March 1977, Huancayo, Peru

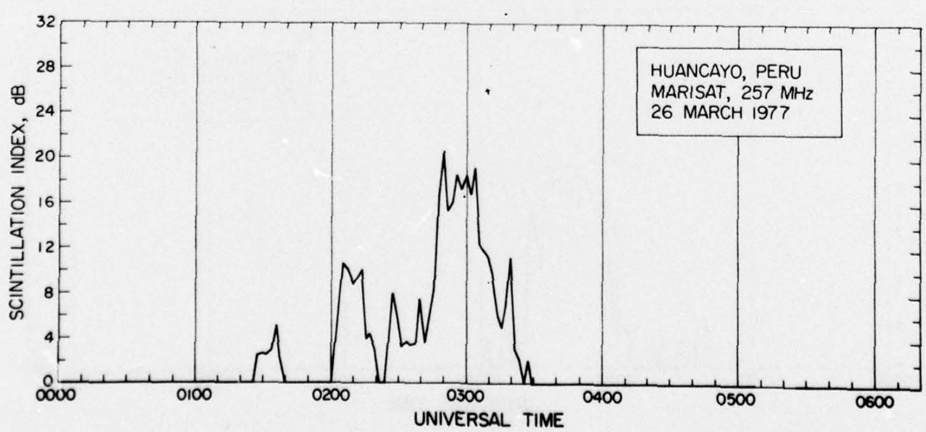


Figure B98. MARISAT, 257 MHz, 26 March 1977, Huancayo, Peru

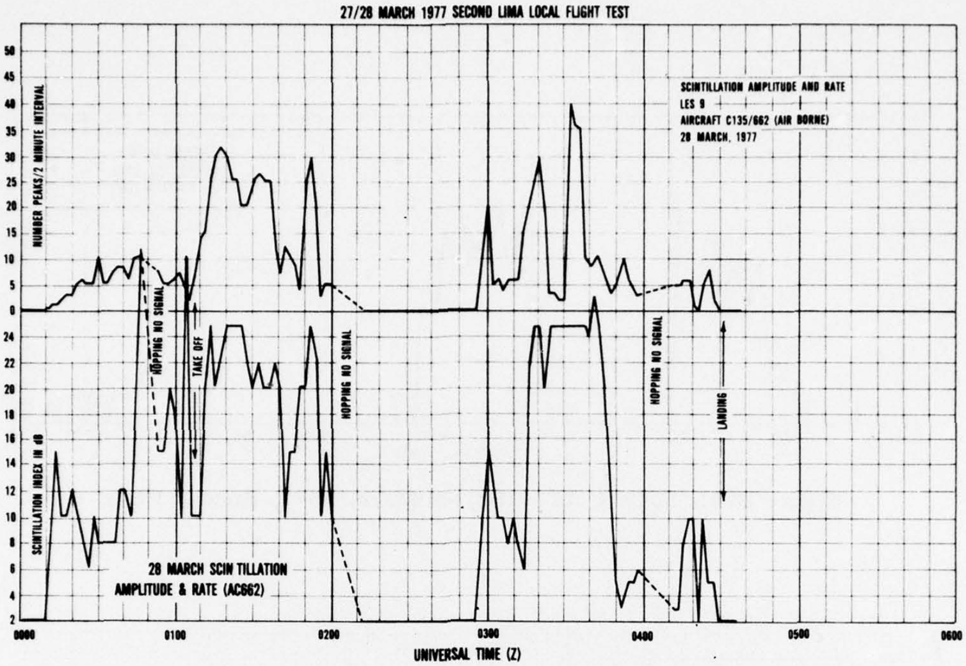


Figure B99. LES-9, Scintillation Amplitude and Rate, 28 March 1977, Aircraft C135/662 (Airborne)

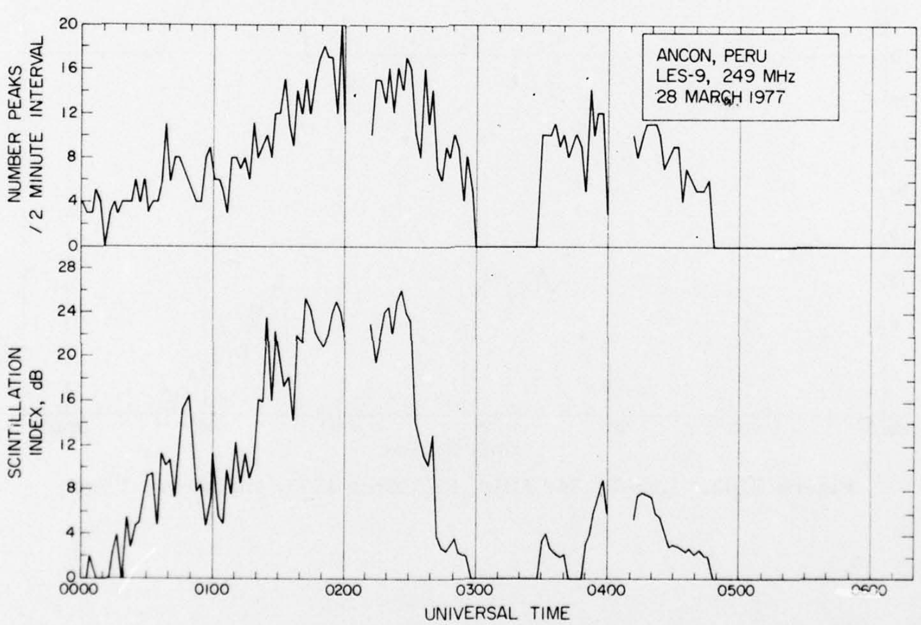


Figure B100. LES-9, 249 MHz, 28 March 1977, Ancon, Peru

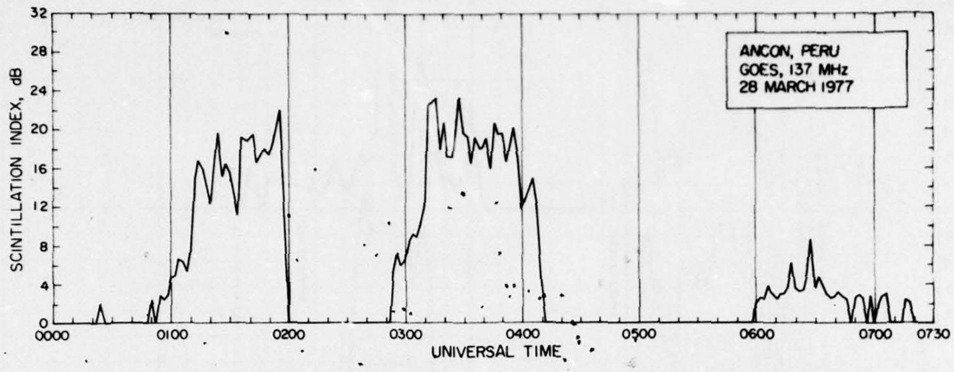


Figure B101. GOES, 137 MHz, 28 March 1977, Ancon, Peru

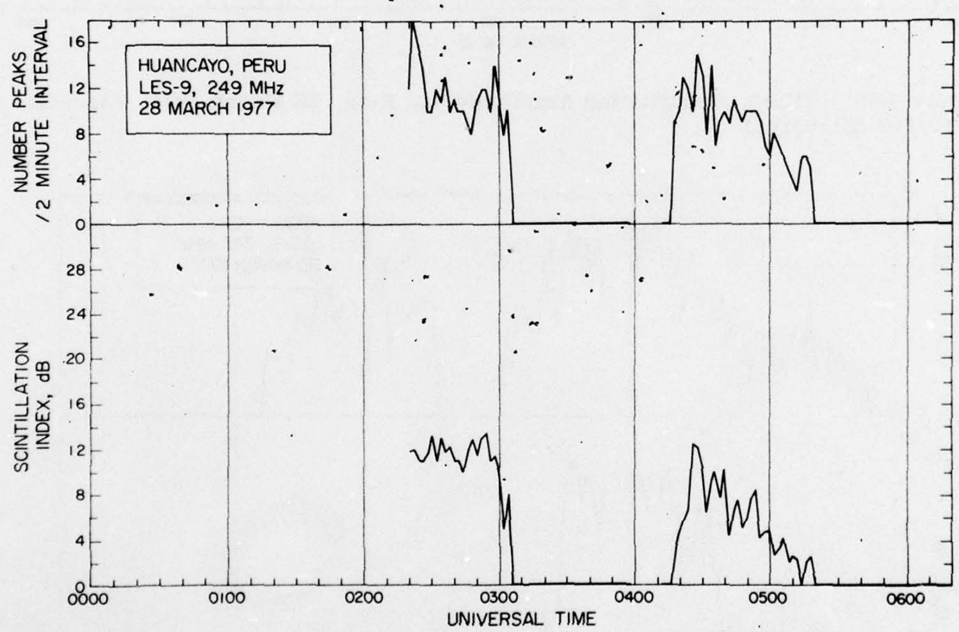
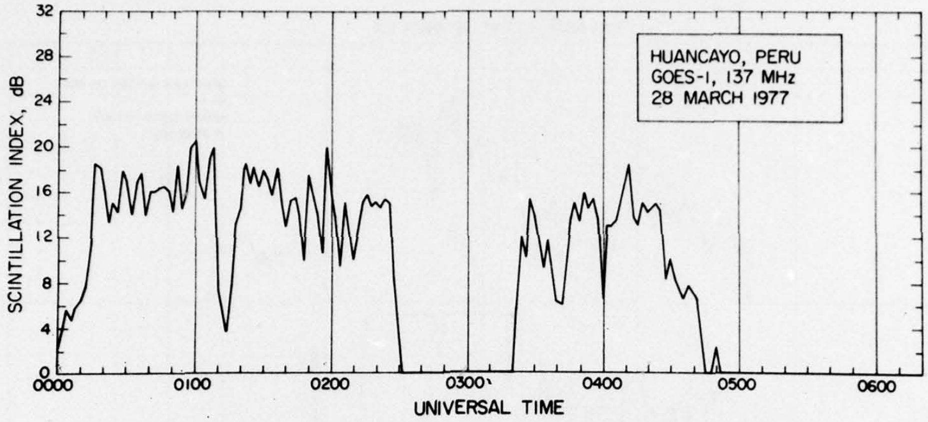


Figure B102. LES-9, 249 MHz, 28 March 1977, Huancayo, Peru



(NO SIGNIFICANT SCINTILLATIONS BEFORE 0000 U.T., 28 MARCH)

Figure B103. GOES-1, 137 MHz, 28 March 1977, Huancayo, Peru

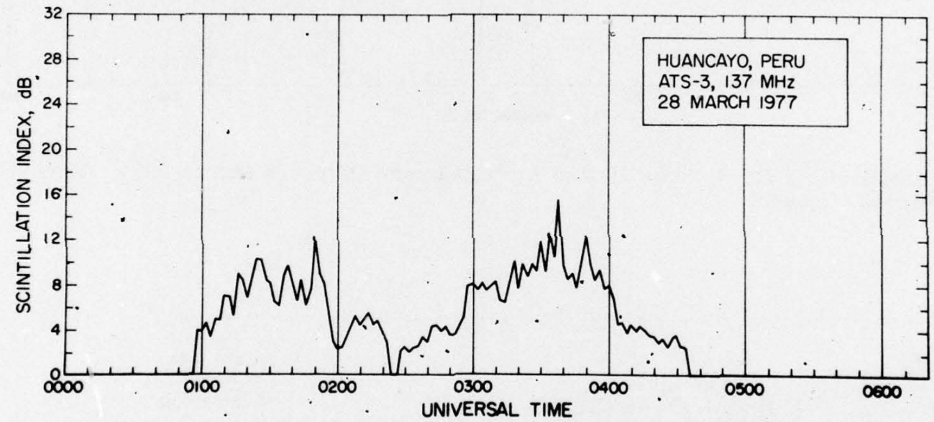


Figure B104. ATS-3, 137 MHz, 28 March 1977, Huancayo, Peru

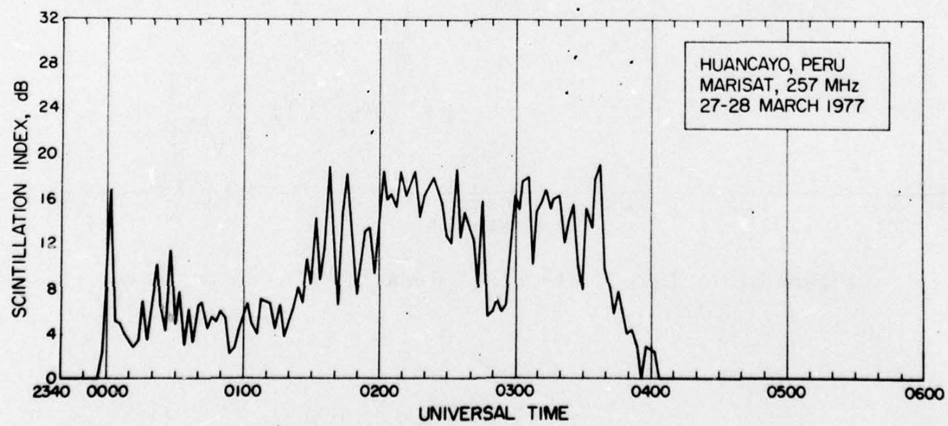


Figure B105. MARISAT, 257 MHz, 27-28 March 1977, Huancayo, Peru

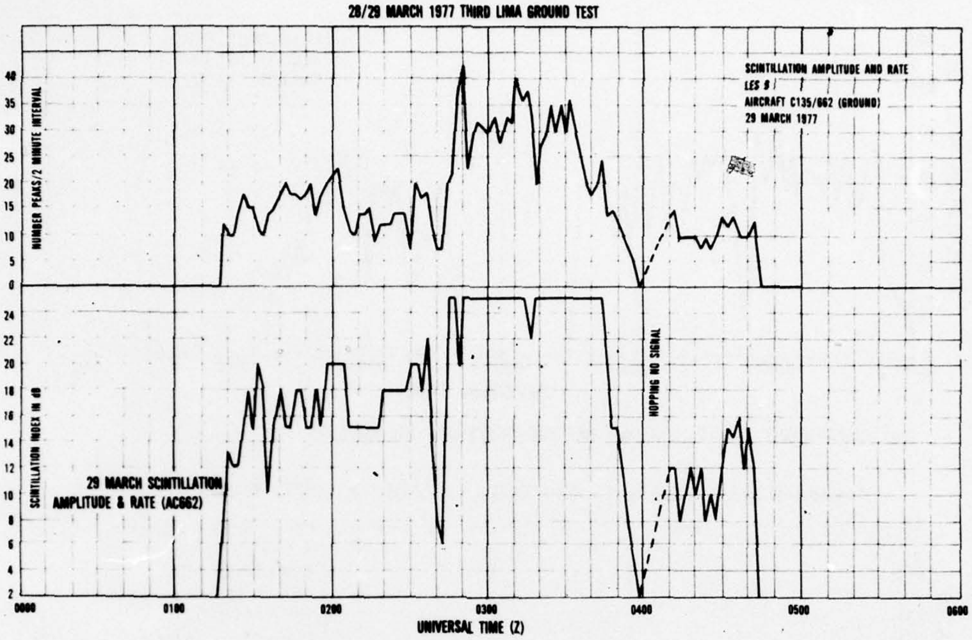


Figure B106. LES-9, Scintillation Amplitude and Rate, 29 March 1977, Aircraft C135/662 (Ground)

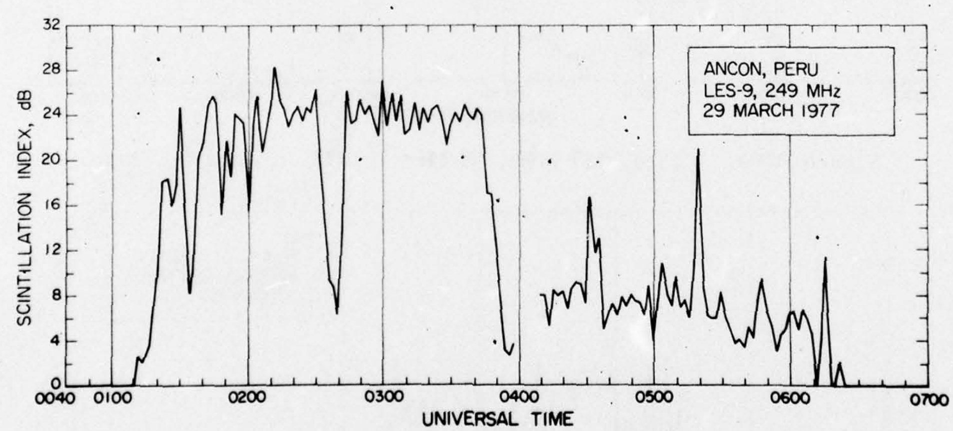


Figure B107. LES-9, 249 MHz, 29 March 1977, Ancon, Peru

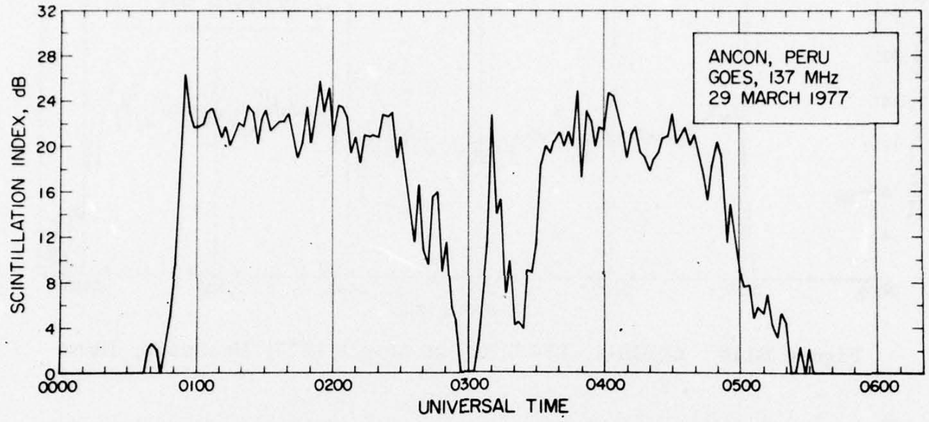


Figure B108. GOES, 137 MHz, 29 March 1977, Ancon, Peru

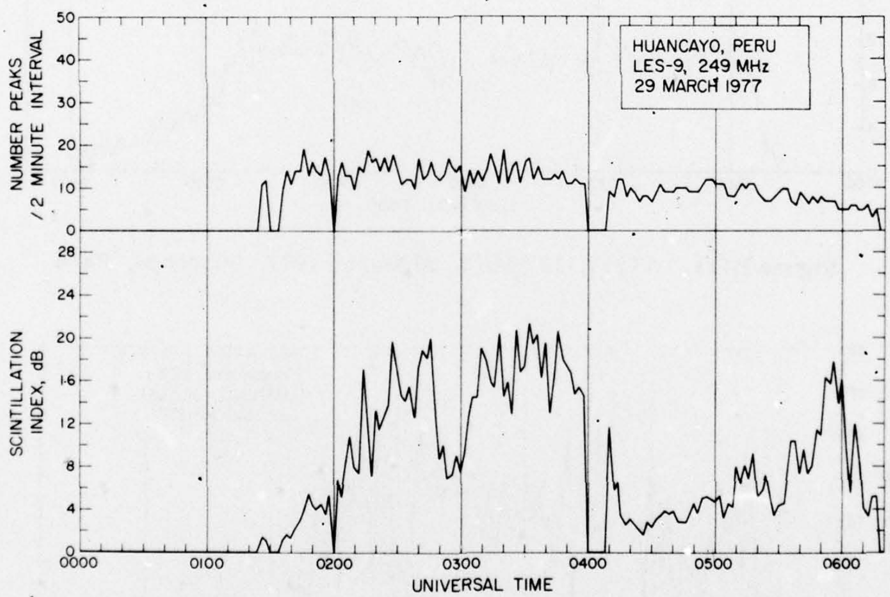


Figure B109. LES-9, 249 MHz, 29 March 1977, Huancayo, Peru

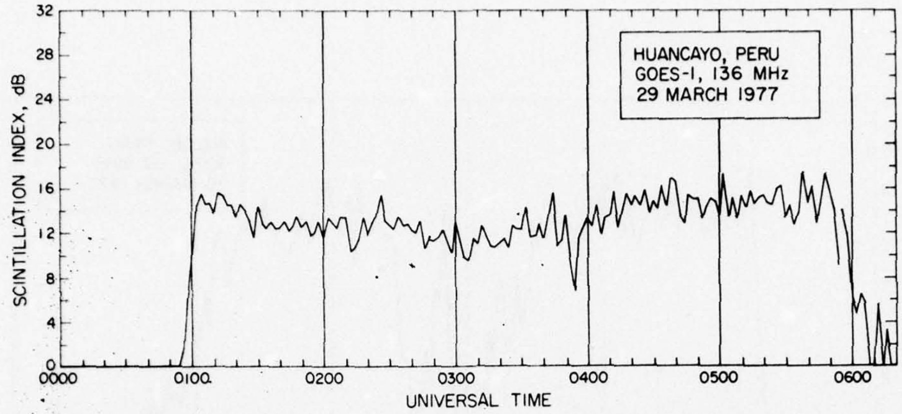


Figure B110. GOES-1, 136 MHz, 29 March 1977, Huancayo, Peru

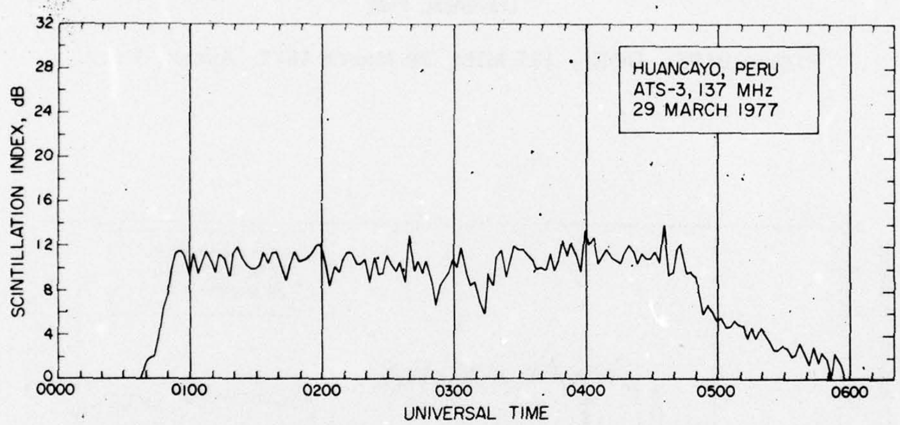


Figure B111. ATS-3, 137 MHz, 29 March 1977, Huancayo, Peru

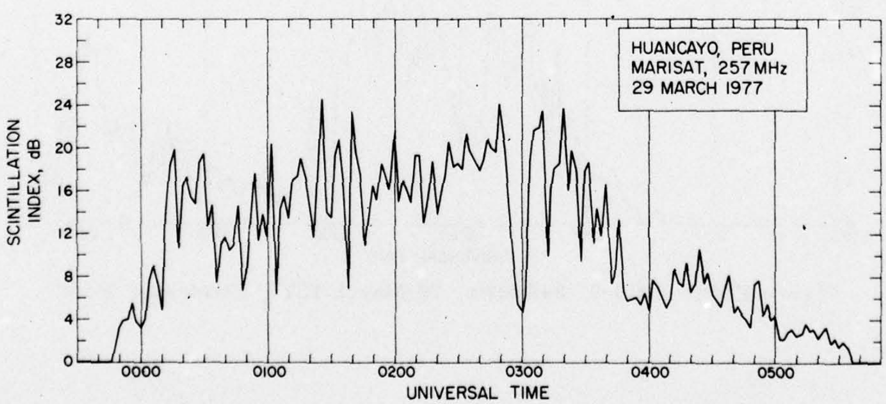


Figure B112. MARISAT, 257 MHz, 29 March 1977, Huancayo, Peru

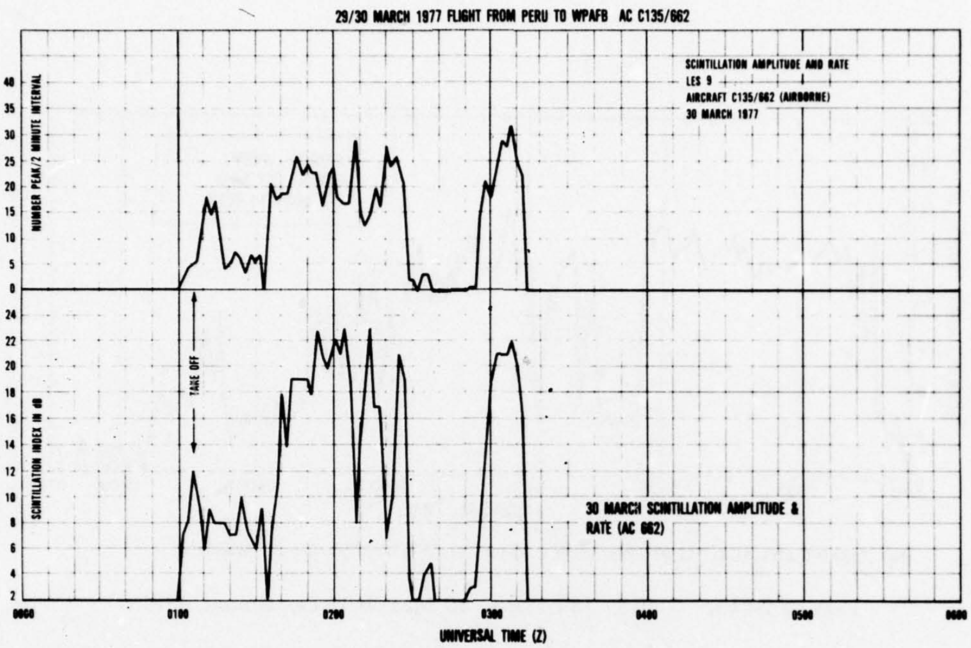


Figure B113. LES-9, Scintillation Amplitude and Rate, 30 March 1977, Aircraft C135/662 (Airborne)

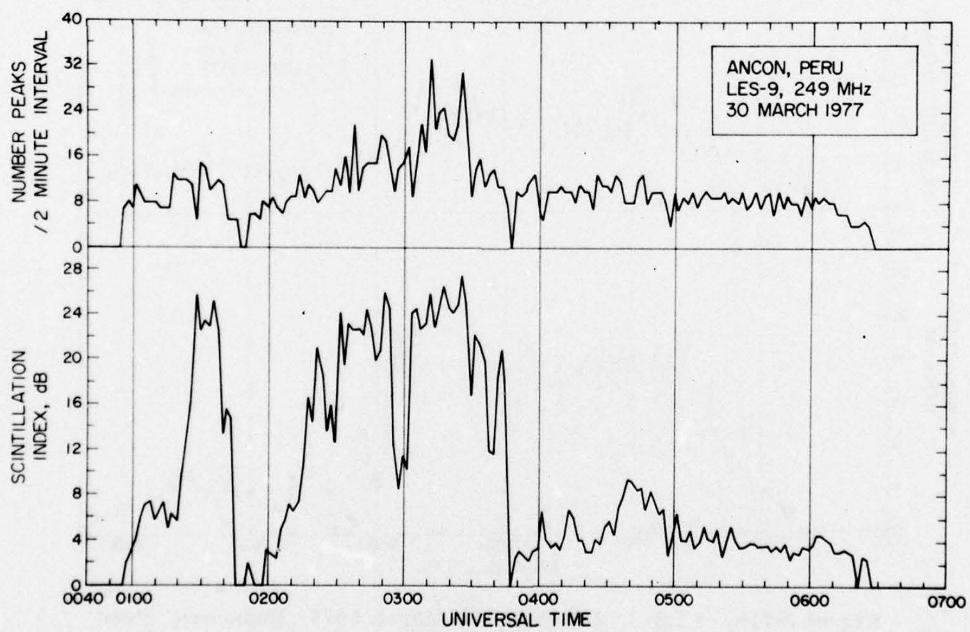
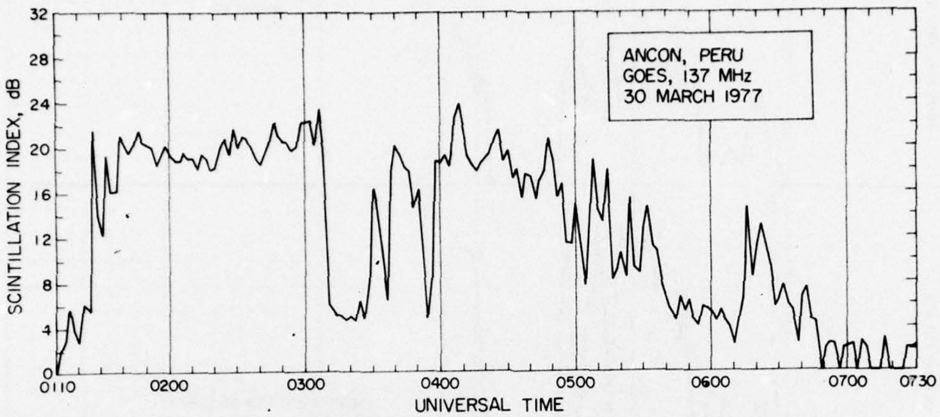


Figure B114. LES-9, 249 MHz, 30 March 1977, Ancon Peru



(NO SIGNIFICANT SCINTILLATIONS BEFORE 0110 OR AFTER 0730 ON 30 MARCH)

Figure B115. GOES, 137 MHz, 30 March 1977, Ancon, Peru

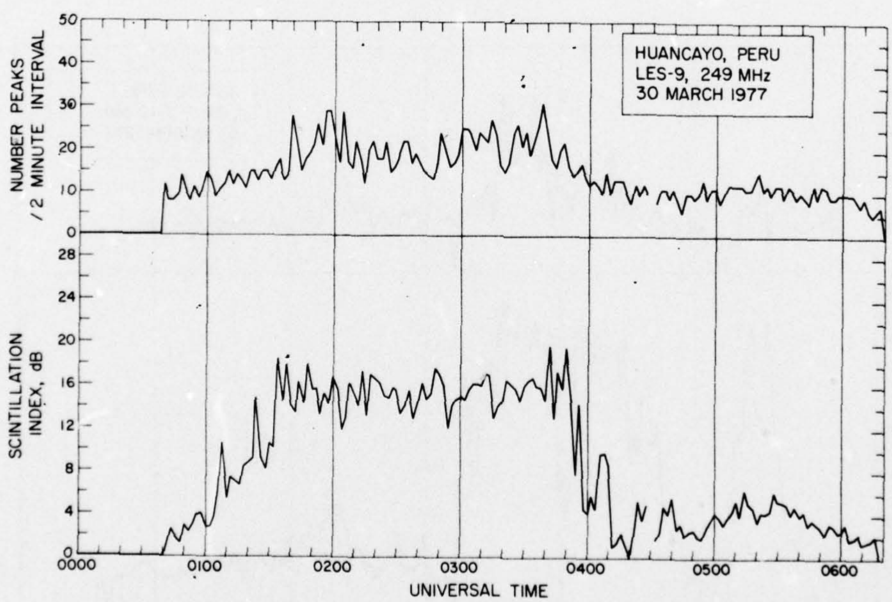


Figure B116. LES-9, 249 MHz, 30 March 1977, Huancayo, Peru

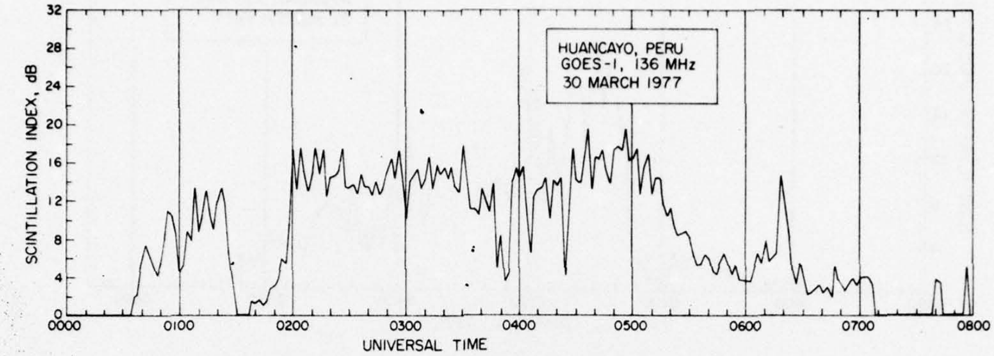


Figure B117. GOES-1, 136 MHz, 30 March 1977, Huancayo, Peru

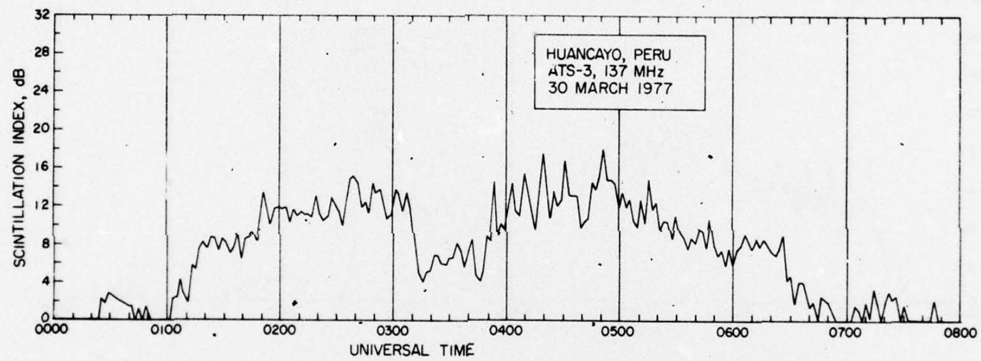


Figure B118. ATS-3, 137 MHz, 30 March 1977, Huancayo, Peru

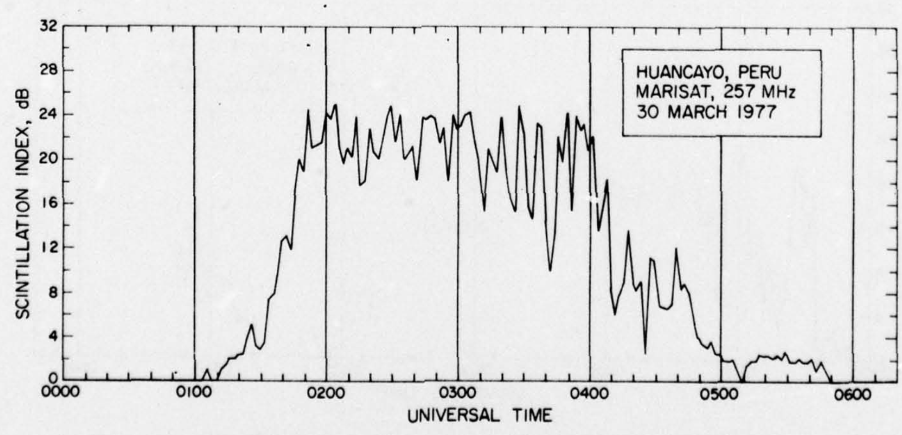


Figure B119. MARISAT, 257 MHz, 30 March 1977, Huancayo, Peru

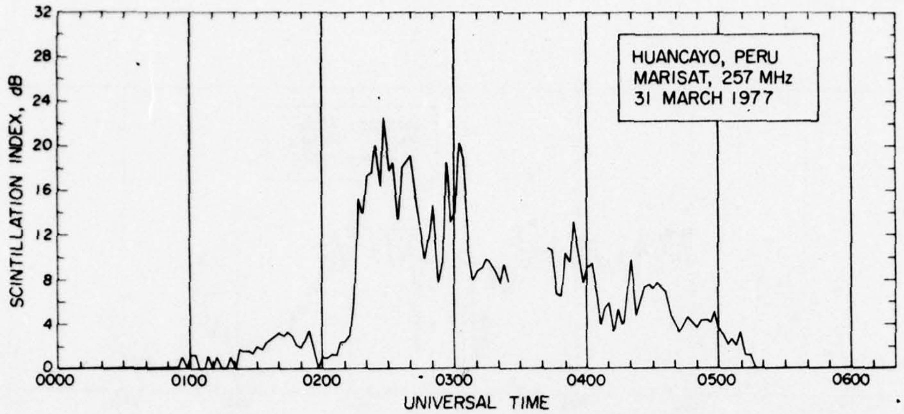


Figure B120. GOES-1, 136 MHz, 31 March 1977, Huancayo, Peru

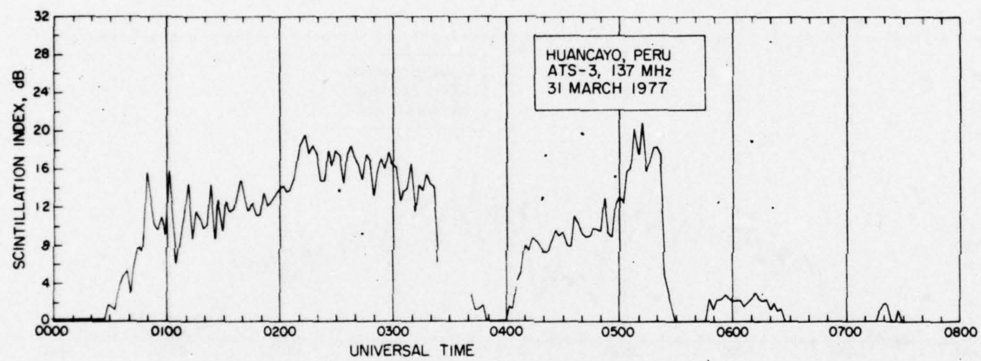


Figure B121. ATS-3, 137 MHz, 31 March 1977, Huancayo, Peru

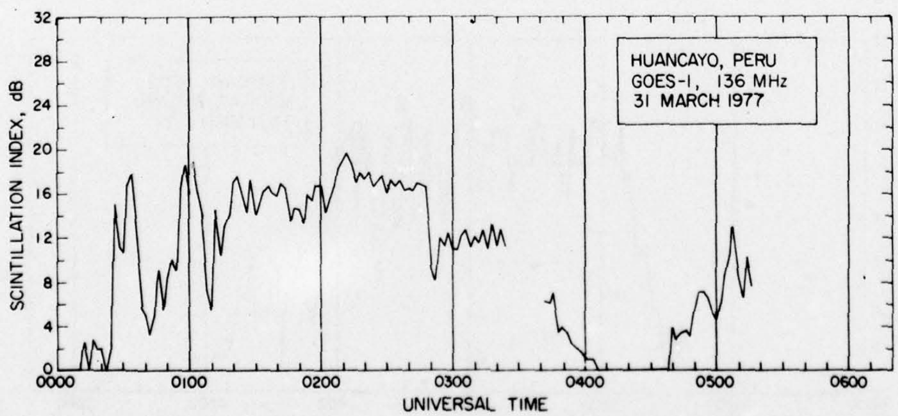


Figure B122. MARISAT, 257 MHz, 31 March 1977, Huancayo, Peru

Appendix C

North/South Aligned Equatorial Airglow Depletions

Abstract

A new instrument for allsky, spectrophotometric imaging of aurora and airglow has been installed in the Air Force Geophysics Laboratory's Airborne Ionospheric Observatory. Initial observations of equatorial and near-equatorial 6300 Å OI airglow show the existence of north-south aligned regions of airglow depletion. These dark bands often extend more than 1200 km in the north-south direction and 50 to 200 km in the east-west direction. They are observed to drift toward the east during the evening-midnight hours, with one observation of westward drift after local midnight. Airglow fine structure associated with the boundaries of the dark bands have been observed down to the 2.5 km resolution limit of the instrument. Simultaneous airborne ionospheric soundings indicate that these regions of airglow depletion are characterized by an increase in the virtual height of the F-layer. A simple model of field aligned electron density depletion in the bottomside of the F-layer, explains both the airglow observations and the ionospheric soundings.

Preface

The authors* wish to thank J. G. Moore for providing the airborne spectrometer measurements, J. W. F. Lloyd for assistance in operation of the allsky imaging photometer, and J. P. McClure and A. L. Snyder for helpful comments in the preparation of this paper.

The success of this airborne expedition is due to the efforts of Maj. Calvin Smith and other members of the 4950th Test Wing, Wright Patterson AFB, Ohio.

This research was supported by the Air Force In-House Laboratory Independent Research Fund of the Air Force Geophysics Laboratory, Air Force Systems Command.

1. INTRODUCTION

A new instrument for monochromatic, allsky observations of auroral and airglow emissions has recently been installed in the Air Force Geophysics Laboratory's Airborne Ionospheric Observatory, an NKC-135 aircraft instrumented for ionospheric research. Initial equatorial airglow and F-region irregularity measurements are presented in this report.

The instrument is a wide field of view, narrow spectral bandwidth, TV system designed to operate in a time exposure mode. A detailed description of a similar system has been given by Mende and Eather[1] and Mende et al.[2]

A series of seven flights were conducted along the west coast of South America in March 1977 to investigate the spatial and temporal characteristics of large scale, F-region irregularities in the vicinity of the magnetic equator. The primary purpose of this expedition was to relate specific dynamical features of the equatorial

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J. Buchau, Air Force Geophysics Laboratory, Hanscom AFB, MA 01731, July 1977.

R. H. Eather, Department of Physics, Boston College, Chestnut Hill, MA 02169, July 1977.

S. B. Mende, Lockheed Palo Alto Research Laboratories, Palo Alto, CA 94304, July 1977.

1. Mende, S. B., and Eather, R. H. (1976) Monochromatic allsky observations and auroral precipitation patterns, J. Geophys. Res. 81:3771.

2. Mende, S. B., Eather, R. H., and Aamodt, E. K. (1977) Instrument for the monochromatic observation of allsky auroral images, Appl. Opt. 16:1691.

ionosphere to the occurrence of signal fluctuations (scintillations) on satellite-to-aircraft and satellite-to-ground VHF/UHF radio transmissions. Optical imaging measurements were performed with the objective of identifying large-scale, airglow structures which are associated with the F-region ionospheric (electron density) irregularities. Simple modeling shows that the existence of a bottomside ionization corrugation or depletion, collocated with the moving band of airglow depletion, can explain the observed ionogram signatures.

2. EQUATORIAL AIRGLOW STRUCTURES

Departures from spatially uniform airglow emission occur as regular features of the equatorial, and near equatorial ionosphere. The prominent intertropical arcs (Barbier[3] and Barbier et al[4]) appear as two bands of enhanced 6300 Å OI which reach maximum intensity at $\pm 12^{o}$ magnetic latitude, and display symmetry with respect to the dip equator. These bands coincide closely in position with the Appleton anomaly region of enhanced F-region electron density. A summary of intertropical arc morphology is presented by Weill[5] and Kulkarni.[6] Smaller scale airglow structures have also been investigated. Steiger[7] presented photometric sky maps of 6300 Å and 5577 Å airglow structure from Haleakala Observatory, Hawaii. These show the existence of localized (~ 500 km diameter) enhancements in 6300 Å intensity, primarily to the south of the observing station. Less frequently, highly structured north-south aligned ridges or fingers of enhanced 6300 Å emission have been observed. The 6300 Å enhancements are frequently accompanied by similar variations in 5577 Å. Van Zandt and Peterson[8] have shown that tropical airglow structures at 6300 Å and 5577 Å can take a variety of forms; from east-west aligned bands or arcs to narrow north-south ridges of alternately enhanced and diminished intensity, arranged along an east-west band. Eastward drift velocities on the order of a few hundred km/hr have been reported for some

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3. Barbier, D. (1961) Les Variations D'Intensite La Raire 6300 Å La Luminescence Nocturne, Ann. Geophys. 17:5.
4. Barbier, D., Weill, G. and Glaume, J. (1961) L'Emission de la Raie Rouge du Ciel Nocturne en Afrique, Ann. Geophys. 17:305.
5. Weill, G.M. (1967) Airglow Observations Near the Equator, Aurora and Airglow, B.M. McCormac, ed., Reinhold Publ. Co., p. 407.
6. Kulkarni, P.V. (1974) Tropical Airglow, Ann. Geophys. 30:105.
7. Steiger, W.R. (1967) Low Latitude Observations of Airglow, Aurora and Airglow, B.M. McCormac, ed., Reinhold Publ. Co., p. 419.
8. Van Zandt, T.E., and Peterson, V.L. (1968) Detailed maps of tropical 6300 Å nightglow enhancements and their implications on the ionospheric F2-layer, Ann. Geophys. 24:747.

of these airglow irregularities. The ridges shown by Van Zandt and Peterson are typically inclined to the West of magnetic north, and are not aligned along magnetic field lines.

From simultaneous ionosonde measurements, both Van Zandt and Peterson,[8] and Steiger[7] conclude that spatial variations in 6300 Å OI intensity result primarily from variations in the height of the F-region rather than from changes in the electron number density at peak of the F-layer. The gradients in 6300 Å intensity along the east-west direction appear, then, to be the result of corrugations in the bottomside of the F2-layer.

3. OBSERVATIONS

Allsky (155° field of view) images of the equatorial airglow were made through 6300 Å and 5577 Å narrow band (~30 Å) interference filters, using alternate 2.5 sec exposures to produce an image at each wavelength every 30 seconds. The resulting TV frames were then recorded on video tape and also by photographing the TV monitors.

Figure C1 presents a series of 6300 Å images (photographs of the tape recorded video frames) obtained during a flight on 17 March 1977, at 15 min intervals between 0100 and 0545 UT. The superposed grid indicates the projection of Corrected Geomagnetic (CG) longitudes (or magnetic meridians) at one degree intervals, for an assumed emission height of 250 km. The flight track for 17 March 1977 was a series of north-south legs (from 3° CG North to 3° CG South) along a magnetic meridian 3° west of Lima, Peru. All images have been reoriented with magnetic North on top as shown in Figure C1. (The reversal of East and West is a result of the display scheme used).

Care must be exercised in the interpretation of features near the edge of the field of view. Although the van Rhijn effect tends to increase, the apparent airglow intensity at large zenith angles (a factor of 2.7 for 75° zenith angle at 250 km emission height), the wide angle lens suffers serious vignetting toward the edge of the field of view (a factor of 3.3 Mende et al[2]). The two effects act in opposition, but vignetting exceeds van Rhijn enhancement at the edges, often resulting in a perceptable dark band around the image for the weak airglow features under consideration. The narrow N-S striations about 1/2° from zenith that can be seen in most images, are the ionosonde antennas which stretch above the allsky lens. They appear east or west of zenith depending on whether the plane is flying North or South.

The images between 0100 UT and 0200 UT show a low level unstructured glow (~ 60 R) with some enhancement towards the South, probably enhanced emission

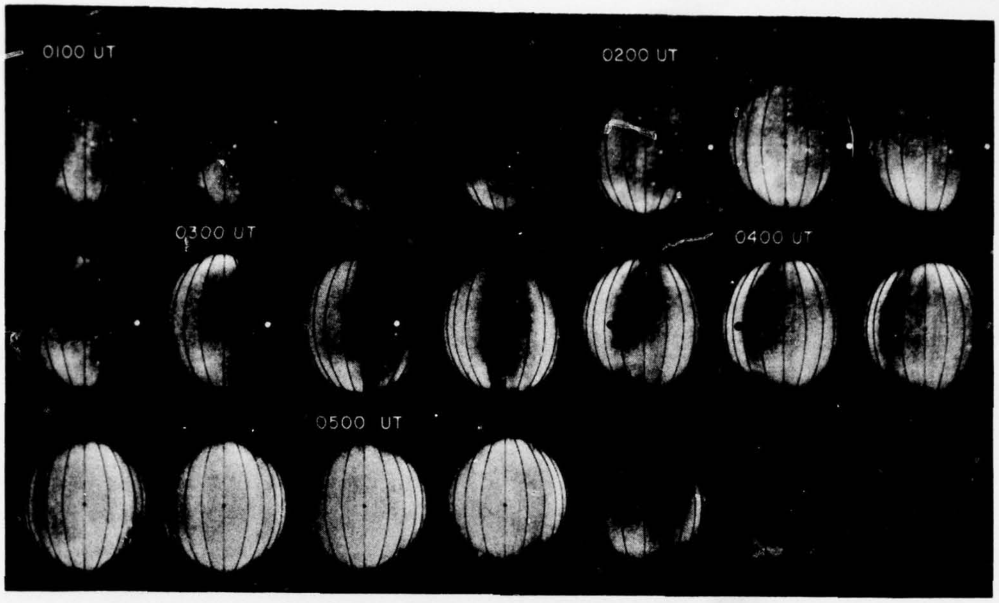

Figure C1. Allsky (155° Field of View) 6300 Å OI Airglow Images at 15 Minute Intervals, From 0100 UT to 0545 UT, 17 March 1977. The superposed grid indicates the projection of C. G. longitudes at one degree intervals, for an assumed emission height of 250 km. The black and white dots represent respectively the location of approaching and receding oblique F-region ionosonde backscatter returns

from the maximum of the Appleton anomaly. The Milky Way is visible in the 0100-0145 UT images as a slight enhancement aligned in the SE-NW direction. The 0215 UT image shows a prominent depletion in the 6300 Å airglow in the form of a dark band which extends from South to North along much of the western horizon. The formation of this dark band can be seen as early as 0200 UT. Within the next 2.5 hr, this band travels across the sky, leaving the instrumental field of view on the eastern horizon by approximately 0445 UT. Generally, the images show that the eastern or leading edge of the airglow depletion is closely aligned in the magnetic North/South direction (best seen in the 0330 UT image). However, inspection of selected images suggests the possibility of a 5° skew (best seen in the 0345 UT image) with the southern end of the edge leading the northern end. A detailed analysis involving the measurement of selected stars is required to eliminate experimental causes (such as small aircraft heading errors) before the precise alignment can be measured. The leading edge displays a sharp intensity gradient in the east-west direction. From absolute airglow intensities, independently measured on the aircraft by a vertically directed, 1 m Ebert-Fastie scanning spectrometer, a decrease from 75 R to 15 R within 100 km has been determined

(J.G. Moore, private communication[9]). The western edge of the depletion region shows a somewhat more gradual, structured transition to the adjacent bright airglow region. The width of the depletion when directly overhead at 0330 UT is approximately 150-200 km. When the region is off-zenith, perspective effects must be considered. It is clear that the region was wider before 0330 UT, but the apparent narrowing after 0330 UT could be due to perspective. The width of the measured depletion region also depends on the detectability threshold of the instrument, so system gain changes can affect the apparent width of these features; but, for the measurements in Figure C1, only small gain changes were necessary. In the North-South direction, these regions extend across the entire field of view to include a horizontal distance of more than 1200 km, assuming a 250 km emission height.

The images at 0415 and 0430 UT show the appearance of a second region of airglow depletion drifting into the field of view from the west. This second region seems to be "filled in" before reaching the aircraft. Unstructured airglow (~150 - 200 R) covers (most of) the observable sky until 0515 UT and then rapidly falls in intensity (~100 R), leaving only minor enhancements towards the southern and western horizons.

4. DRIFTS

The CG Longitude of the eastern and western edges of the airglow depletion, on an east-west great circle through the aircraft zenith, were determined for the feature in Figure C1. The results (Figure C2) indicate that the depletion drifted toward CG East with a relatively constant velocity of ~90 m/sec, while maintaining an east-west dimension of ~165 km. Eastward drifts from 50 to 100 m/sec were observed on other local evening flights. During a flight from Lima, Peru to Homestead AFB, Florida on 26 March 1977, a clear reversal from eastward to westward drift was observed. This occurred in the midnight (0035 LT) sector with the aircraft located at 16° CG Latitude. This was the only observation of westward drifts during the expedition.

9. Moore, J.G. (1977) Private communication.

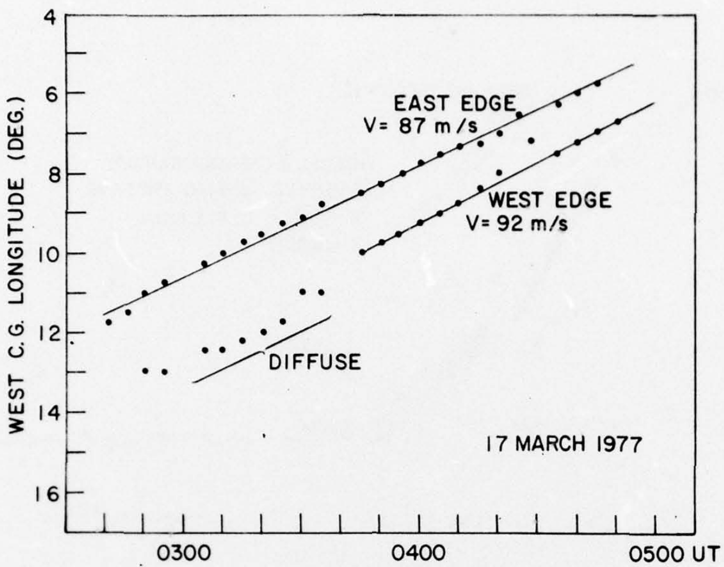

Figure C2. The C.G. Longitude of the Eastern and Western Edges of the Airglow Depletion Shown in Figure 1

5. IONOSONDE MEASUREMENTS

Figure C3 presents results of the ionospheric soundings conducted simultaneously onboard the aircraft. The virtual height of the observed F-layer and the virtual range of oblique F-layer echoes is shown as a function of time. The oblique echoes are first observed at a virtual range of 800 km at 0157 UT, almost coincident with the initial observation of the airglow depletion on the western horizon. These oblique returns close in range, consistent with the approach of a reflecting or scattering region, and merge with the overhead F-layer by 0317 UT.

By 0335 UT oblique echoes are seen to separate from the lowest F-region trace and to increase in range to about 350 km by 0354 UT. After this time they are obscured by other returns and cannot be further identified. Even though the omnidirectional sounder antenna does not permit determination of the angle of arrival of the oblique echoes, the coinciding time histories of the airglow depletion movement and the backscatter range change suggest that the sounder observes the motion of ionospheric scattering regions associated with the motion of the depletion. Assuming a height of 250 km for the scattering region, ranges of the approaching backscatter front were converted to ground distances. The estimated locations of these approaching scattering regions are shown as white dots in the respective airglow images in Figure C1, to the west of zenith. Ground ranges

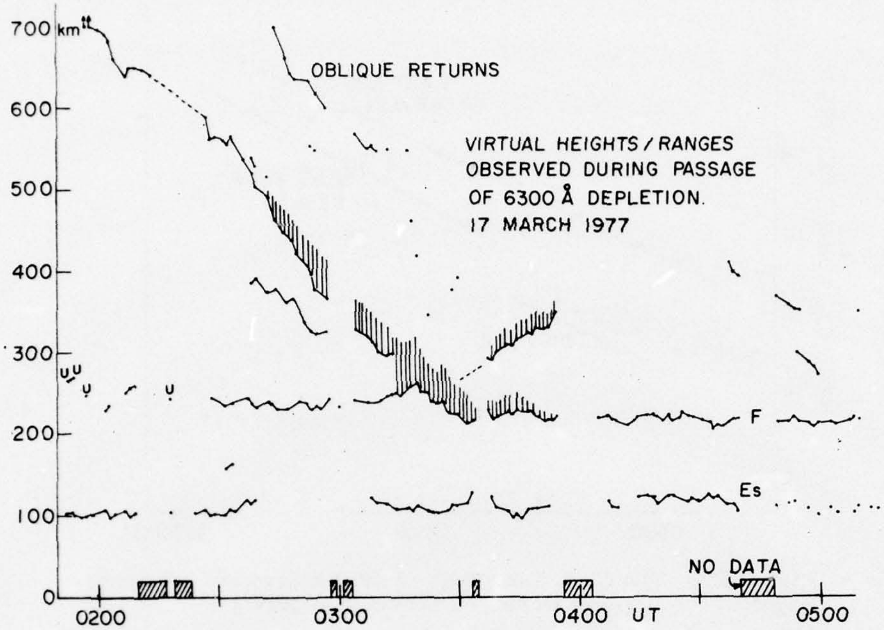

Figure C3. Virtual Height/Range Plot of Ionosonde Returns Associated With the 6300Å Airglow Depletion. The shaded areas represent range spread on backscatter returns or overhead spread F conditions

derived from the receding backscatter branch, observed after the overhead passage of the leading edge of the depletion, were entered as black dots to the east of the zenith of the respective images. As Figure C1 shows, best seen in the 0245 to 0315 UT images, the approaching backscatter is tracking the trailing (western) edge of the depletion, while the leading (eastern) edge is tracked by the receding echoes observed after 0330 UT.

A model of an ionization depletion in the bottomside of the ionosphere, shown in Figure C4, produces a sequence of approaching and receding echo traces as well as a variation in h'F, which closely resemble the observations. With the aircraft located to the east of the structure, returns are received vertically and via ray path b1; after passage of the structure to the east of the aircraft, returns are received vertically and via ray path b2. From the allsky images, the width of the structure has been taken as 165 km and the velocity as 92 m sec^{-1}. The time of passage of the eastern edge through the aircraft zenith was determined as 0308 UT. The virtual heights of the F-layer prior to and after the passage of the

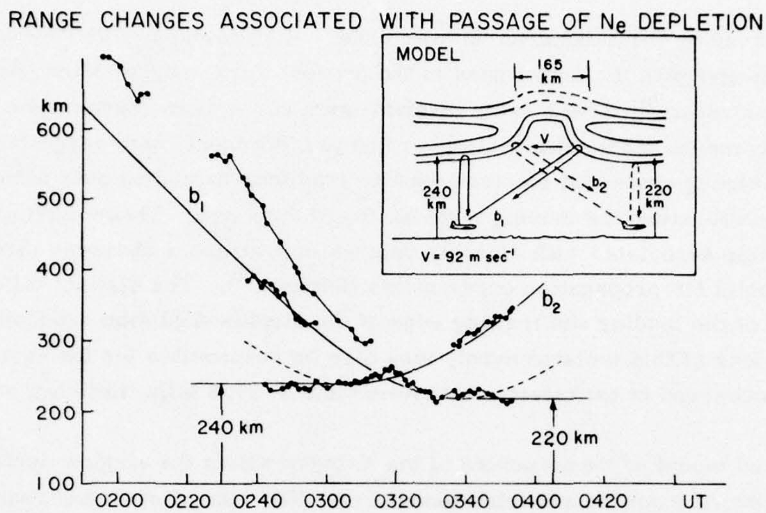

Figure C4. Model of an Eastward Drifting, Bottomside Ne Depletion or Corrugation Based on Observed Ionosonde and Airglow Parameters. The measured ranges of oblique returns and the virtual height of the overhead F-region are compared with range/height changes expected from the passage of the model bottomside structure over the ionosonde

depletion, were taken from Figure C3 as 240 km and 220 km respectively. Figure C4 shows the result of the model computations with the relevant sections of the h' plot from Figure C3 superimposed.

The fit is generally good, but additional strong returns associated with the trailing edge of the depletion at ranges larger than derived from the simple model, and approaching at a greater speed suggest a more complex structure of the trailing edge than modelled. Analysis of the 16 mm photographic record, with 30 sec time resolution, shows distinct structure with turbulent motion at the western edge of the depletion, in contrast to the smooth and stable features observed at the eastern edge. The east-west asymmetry is also visible in Figure C1. The 0330 UT image shows diffuse and patchy structure at the trailing edge compared to the well defined leading edge. These features may be responsible for the more complex ionosonde backscatter associated with the trailing edge. The model used to explain the sounder measurements is a simplification of the bottomside effects of an instability model proposed by Woodman and La Hoz,[10] to describe the development and subsequent upward propagation of bubbles of low electron density in the equatorial F-region. This process explains the time history of irregularity structures or

10. Woodman, R.F., and La Hoz, C. (1976) Radar observations of F-region equatorial irregularities, J. Geophys. Res. 81:5447.

plumes observed by the Jicamarca 50 MHz radar. Comparison of the Woodman and La Hoz model with the model used in the present work, suggests that the airglow depletions described here are a manifestation of the same phenomenon leading to the Jicamarca plume observations. The present model also suggests the existence of strong east-west electron density gradients extending over a considerable north-south extent and moving in an eastward direction. These moving fronts are presumably associated with discrete patches of scatterers observed through trans-equatorial HF propagation experiments (Röttger[11]). The distinct difference in structure of the leading and trailing edge of the airglow depletion deduced from the observations of this isolated event, may also be responsible for the east-west asymmetry observed in backscatter measurements at 27.8 MHz (Kelleher and Skinner[12]).

A detailed model of the structure of the F-layer within the airglow depletion cannot be deduced from the available ionograms. The ionogram traces required to establish the Ne (h) profiles are either obscured by the scattered reflections received from the edges of the depletion (see Figure C4), or the traces do not exist due to the irregular structure within the depletion. This limitation of ionosondes to establish profiles within regions of strong horizontal gradients is well known in the high latitude ionosphere; although the main F-layer trough is clearly identifiable in ionograms, the profiles inside the trough cannot be determined due to the narrowness of the depletion (Lobb and Titheridge[13]).

After the approaching trace merged with the overhead trace, strong unstructured spread F developed, and persisted for the period of passage of the depletion. Throughout the evening, the F-layer had come down, initially from 275 km (0000 UT) to 230 km (0300 UT) just prior to the overhead arrival of the leading edge of the depletion. The layer rapidly moved upwards by 35 km, reaching a maximum h' of 265 km by 0319 UT, the time of strongest spread F. After this, the layer again rapidly moved down to 215 km (0332 UT) and fluctuated around this level for the remainder of the observations. Some close range oblique echoes between 0437 UT and 0500 UT are possibly remnants of the ionospheric disturbance associated with the short-lived depletion observed near the western horizon between 0415 UT and 0430 UT.

Observations of foF2 between 0100 and 0500 UT are rather uncertain because of spread conditions and high nighttime HF noise levels, but in general foF2

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11. Röttger, J. (1973) Wave-like structures of large scale equatorial spread-F irregularities, J. Atmos. Terr. Phys. **35**:1195.
12. Kelleher, R.P., and Skinner, N.J. (1971) Studies of F-region irregularities at Nairobi, Ann. Geophys. **27**:195.
13. Lobb, R.J., and Titheridge, J.E. (1977) The effect of travelling ionospheric disturbances on ionograms, J. Atmos. Terr. Phys. **39**:129.

fluctuated between 8.5 and 9.5 MHz. After 0500 UT the spread and noise conditions improved and a clear decrease of the foF2 from 9.2 MHz (0503 UT) to 8.0 MHz (0523 UT) and finally to 5.8 MHz (0549 UT) is observed, which follows the decrease of the overall brightness of the 0500 UT to 0545 UT allsky photometer images. Since h'F does not change appreciably (from 212 km at 0503 to 226 km at 0549 UT), this change in airglow level is directly attributable to the Ne decay.

6. UHF AMPLITUDE SCINTILLATIONS

During this flight, UHF amplitude measurements were made on the aircraft using the Lincoln Experimental Satellite (LES-9) 249 MHz down link transmissions. Fortunately, the direction to the satellite positioned the ray path through the east-west dimension of the airglow depletion, and the eastward drift effectively moved the ray path from lower to higher altitudes through the region. It is important to

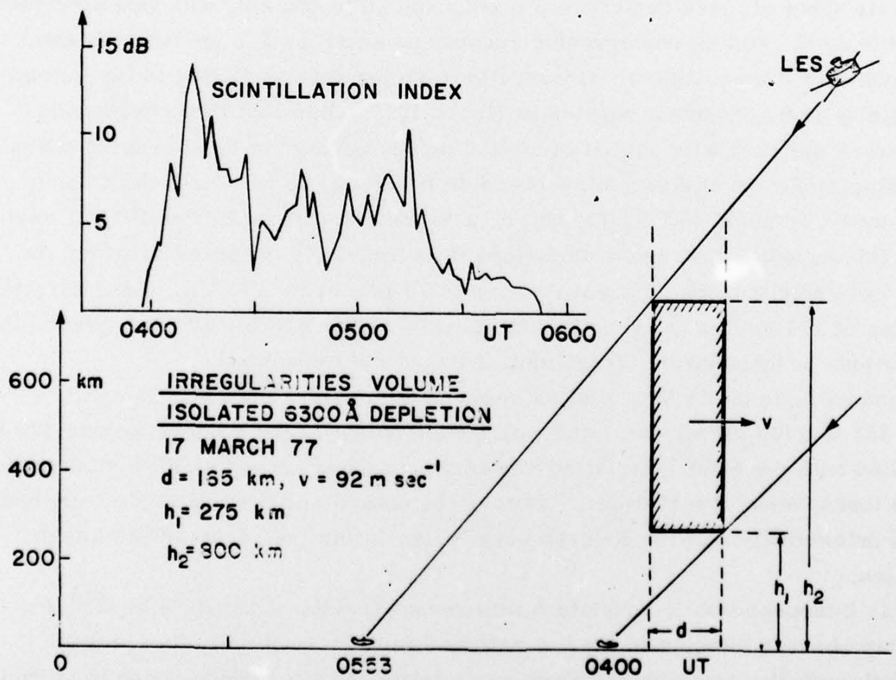

Figure C5. UHF Amplitude Scintillation Index Associated With the Passage of the Ionization Depletion Through the Satellite-to-Aircraft Ray Path

note that the airglow depletion is a bottomside signature and, as such, does not reflect characteristics of the topside ionosphere.

Comparison with other types of measurements (Jicamarca Incoherent Radar, aircraft ionosonde, satellite ion and electron density probes) leads to the conclusion that the airglow depletions define the horizontal dimensions of a region of low electron and ion density, which extends upward through the F-region often to 1000 km. Ionospheric electron density irregularities with scale sizes from 3m to 10's of km exist within these depletion regions.

The effect of UHF propagation through the depletion region is shown schematically in Figure C5. A rapid onset of 7-14 dB scintillations began at 0400 UT as the ray path reached a height of 275 km within the depletion. Scintillations continued until 0553 UT, which corresponds to an altitude of 800 km.

7. SUMMARY AND DISCUSSION

Monochromatic, allsky imaging has revealed the existence of North-South (magnetic) aligned regions of airglow depletion in the equatorial F-region. East-west scale sizes of these depletions ranged from 50 to 200 km, with fine structure detectable on the 16 mm photographic records as small as 2.5 km (instrumental resolution at 250 km altitude). Observations during several flights in the immediate vicinity of the magnetic equator in March 1977, show that these depletions drift toward the East with speeds of 50-150 m/sec during the local evening hours. One example of a reversal from eastward drift velocity to westward drift was observed in the midnight (0035 LT) sector, with the aircraft located at 16^{o} CG North. During this expedition, airglow depletions were regularly observed provided the virtual base height of the adjacent F-layer (h'F) was below 275 km. Base heights in excess of 275 km lead to greatly diminished airglow intensities, thus precluding observations of ionospheric irregularities by optical techniques.

A model bottomside Ne depletion, extending for more than 1200 km north-south, 10C to 200 km east-west and with a base height of the F-layer around 300 km, collocated with the 6300 Å depletion explains both the observed airglow structure and the ionospheric observations. Neither the optical nor the ionosonde techniques allow a determination of the F-layer base height within the region of diminished ionization.

This interpretation is consistent with recent results of McClure et al[14] who regularly observe biteouts in the ion density after sunset of up to 3 orders of magnitude with the Atmospheric Explorer satellite AE-C. These range in altitude

14. McClure, J.P., Hanson, W.B., and Hoffmen, J.F. (1977) Plasma bubbles and irregularities in the equatorial ionosphere, J. Geophys. Res. 82:2650.

from the peak of the F-layer up to ~600 km and have typical upward plasma velocities of several tens to several hundred m/sec. The model used to explain the sounder observations has strong similarities with the response of the bottomside to a bubble model proposed by Woodman and La Hoz.[10] From the similarity of the two phenomena, and the models, it is reasonable to postulate that airglow depletions are the optical signatures of these biteouts or bubbles.

Satellite-to-aircraft signal strength measurements show that propagation through the plasma depletion leads to amplitude scintillation. The altitude range over which scintillation producing irregularities exist, is consistent with plasma bubble measurements of Woodman and La Hoz,[10] and the topside measurement of McClure et al.[14]

Because of the complementary nature of satellite plasma measurements and airborne imaging photometer measurements, coordinated experiments would provide insight into the initial development of these regions of upward plasma flow. Also, the ability of an airborne observatory to monitor a particular region of airglow depletion for several hours would allow successive satellite measurements of ion composition changes during the lifetime of a single bubble.

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